UNITED STATES COMMISSION OF FISH AND FISHERIES.

PART X.

REPORT

OF

THE COMMISSIONER

FOR

1882.

A.—INQUIRY INTO THE DECREASE OF FOOD-FISHES.
B.—THE PROPAGATION OF FOOD-FISHES IN THE WATERS OF THE UNITED STATES.

WASHINGTON:
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1884.

LETTER

FROM THE

COMMISSIONER OF FISH AND FISHERIES,

TRANSMITTING,

In compliance with law, his report for the year 1882.

FEBRUARY 23, 1883.—Ordered to lie on the table and be printed.

UNITED STATES COMMISSION OF FISH AND FISHERIES,
Washington, D. C., January 11, 1883.

GENTLEMEN: In compliance with the order of Congress, I have the honor to transmit herewith my report for the year 1882, as United States Commissioner of Fish and Fisheries, embracing, first, the result of inquiries into the condition of the fisheries of the sea-coast and lakes of the United States; and, second, the history of the measures taken for the introduction of useful food-fishes into its waters.

Very respectfully, your obedient servant,

SPENCER F. BAIRD,
Commissioner.

Hon. DAVID DAVIS,
President of the United States Senate, and
Hon. J. W. KEIFER,
Speaker of the House of Representatives.

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REPORT OF THE COMMISSIONER.

A.—GENERAL CONSIDERATIONS.

1.—INTRODUCTORY REMARKS.

In presenting herewith the tenth of the series of annual reports upon the work of the United States Fish Commission, being for the year 1882, I hope to show a continued increase in the extent and efficiency, and, I trust, utility, of its work.

A volume has been published annually, with a single exception, when, for reasons explained at the time, the reports for the years 1873-'74, and 1874-'75, were combined.

The establishment of the Commission in 1871 at the time appeared to be but a slight incident in the history of the country. As previously shown the work first intrusted to the Commission was that of investigating the alleged decrease in the food-fishes of the United States, and it was not until the second year of its existence that action looking towards the propagation of food-fishes, and their transfer to, or multiplication in, the waters of the United States was ordered and authorized.

With the acquisition, by the favor of Congress, of steamers capable of carrying on work in the ocean, as well as in the interior waters, the possibilities of usefulness have become greatly extended, and much has been attempted as well as accomplished. In addition to the regular work of the Commission, it has become possible to do a great deal for the advancement of science in general, especially by prosecuting researches into the general natural history of the aquatic animals and plants, either by the Commission itself or by specialists to whom the facilities of the service are extended in the way of use of boats, of stations, and of material.

The Commission has also made very large collections of aquatic animals, especially of fishes, shells, corals, crustaceans, star fishes, &c., and after submitting them to a careful investigation for monographic research, and setting aside a full series for the National Museum, the remainder has been made up into well identified and labelled sets for distribution to colleges, academies, and other institutions of learning throughout the United States. The educational advantages of this last measure have proved to be of the utmost value, and are thoroughly appreciated by teachers throughout the country. Applications for these sets are being continually received, and several hundreds of them have already

been supplied, a number of persons being occupied for a good part of their time in preparing to meet additional calls. There is nothing which so much increases the interest in natural history as the opportunity of examining actual specimens of rare, and, usually unprocurable, species, instead of depending upon descriptions or drawings; and as the possibility of obtaining these series becomes the better known, it is quite likely that all the resources of the Commission for making collections, great as they are, will be fully taxed.

The calls for these specimens are usually made through the member of Congress representing the district in which the institution is established; or, if made direct to the Commission, they are referred to the member for his indorsement and recommendation.

Some of the most noteworthy features of the year 1882 are as follows:

1. The appropriation made by Congress to supply the full amount necessary for the construction of the new steamer Albatross and the completion of the vessel.

2. The change in command of the steamers of the Fish Commission by the transfer of Lieutenant Tanner from the Fish Hawk to the Albatross, and of Lieutenant Wood from the Lookout to the Fish Hawk.

3. The purchase and employment of a Herreshoff launch, No. 82 of his series.

4. The acquisition of land at Wood's Holl for a permanent sea-coast station.

5. The appropriation made by Congress for the improvement of Wood's Holl harbor by the construction of a pier and breakwater, to be utilized indirectly in the interest of the Fish Commission and its operations.

6. The fitting up of the Armory building as a station both for hatching and for the distribution of fish, and establishing it as the central Washington station; the bringing of a branch track from the Baltimore and Potomac Railroad into the grounds, and their inclosure by a substantial high fence; also the erection of a large storage-shed.

7. The appropriation by Congress for the participation by the United States Fish Commission in the London International Fisheries Exhibition.

8. The proposed action by Congress in regard to the construction of a fishway in connection with the dam at the Great Falls of the Potomac.

9. The acquisition by the Commission of the control of the grounds at Wytheville, Va., belonging to the Virginia State Fish Commission, and the fitting them up specially for the hatching of California trout.

10. The transfer of the control of Saint Jeromes Station from the Maryland Fish Commission to that of the United States.

11. The commencement, on a large scale, of preparations for the artificial propagation of oysters at Saint Jeromes.

12. The practical completion of the work undertaken by the Fish Commission for the census of 1880.

13. The order of Congress to print a large work in three quarto volumes upon the fisheries of the United States.

14. The great expansion in the work of production and distribution of the carp.

15. The practical extermination of the tile-fish in the North Atlantic.

These several points will be more fully discussed in their appropriate places in the report.

A brief memorandum of what the United States Fish Commission hopes to accomplish in time, in connection with its mission, is as follows:

1. In the department of investigation and research there is yet to be carried out an exhaustive inquiry into the character, abundance, geographical distribution, and economical qualities of the inhabitants of the waters, both fresh and salt. The subject is practically unlimited in extent, and, so far as the ocean is concerned, has been scarcely touched. With the powerful apparatus, however, at the command of the Commission, it is expected that much progress will be made, year by year, and the publication of the results and the distribution of duplicate specimens to colleges and academies in the United States be carried out on a large scale, so as to meet a large and increasing demand with teachers and students.

2. The second object, in connection with the sea fisheries, is the improvement of the old methods and apparatus of fishing and the introduction of new ones.

The work of the Commission, in bringing to the notice of American fishermen the importance of gill nets with glass-ball floats for the capture of cod-fish, has already revolutionized the winter cod-fishery industry in New England. Looked upon almost with ridicule by the Gloucester fishermen when first brought to their notice by the Commission, these nets have come rapidly into use, until, at the present time, they represent the most important element in the winter fisheries, the number of fish taken being not only much greater, but the fish themselves of finer quality.

The ability to maintain a successful fishery without the use of bait is of the utmost importance, in view of the fact that when cod are most abundant bait is almost unprocurable. Other forms of apparatus, of less importance, have also been introduced, and a constant lookout is maintained, by correspondence and otherwise, in connection with the improvement of fishing machinery.

Among the subjects to which the attention of the Fish Commission has been directed is that of the best method of preserving nets in a condition for continued use by preventing them from rotting.

Netting is usually treated by saturating it with some repellant substance, which prevents the moisture from remaining in the interstices of the thread or causes it to dry more rapidly. The usual practice is to soak the nets in a solution of catechu, tannin, or other astringent preparation, or else to apply tar or asphaltum. Salting is also frequently practiced.

A material has lately been offered by Messrs. Horner & Hyde, of Baltimore, which promises good results. Another preservative has also been offered from California, but has not yet been received in sufficient quantity to be tested.

An article by Professor Storer on this subject will be found in the appendix.

3. Another important point for consideration is that of improvement in the pattern of fishing-vessels. There is annually a terrible mortality in the fishing crews of New England, especially those belonging to the port of Gloucester, to say nothing of the total loss and wreck of the fishing vessels and their contents. There has gradually developed in connection with the mackerel and cod fisheries of New England a pattern of vessel which, while admirable for speed and beauty of lines and of rig, is less safe under certain emergencies than the more substantial and deeper vessel used abroad, especially in England and Scotland.

The subject of the best form of fishing-vessel has been intrusted to Captain Collins, of the Commission, himself a most experienced fisherman, and, after a careful study of the boats of all nations, he has prepared a model which is believed to combine the excellencies of both English and American vessels.

An appropriation will be asked from Congress for means to construct an experimental vessel and test its qualities; but until a successful experiment has been made, it will be difficult to induce the fishermen to change their present form of construction.

4. The fourth object of the Commission is to determine the extent and general character of the old fishing localities and to discover new ones. There is no doubt whatever that there still remain many important areas, even in the best known seas, where the cod-fish and halibut will be found in their old abundance.

There has never been any formal investigation on this subject, and the banks that are known have been brought to light purely by accident. It is believed that by a systematic research and a careful survey the area of known grounds can be greatly extended.

There is even more reason to hope for successful results from this inquiry in the waters off the south Atlantic coast and in the Gulf of Mexico. These regions, the latter especially, may be considered as practically unknown, the few established localities for good fishing being in very small proportion to what must exist. It is here that the service of the fishing schooner referred to above, if means can be obtained to build it, will be brought into play, and it is not too much to hope that an industry will be developed that will represent to the Southern and Southeastern States the same source of income and occupation that the mackerel, cod, and halibut furnish to the fishermen of New England.

5. There is also much to be learned in the way of curing and packing fish for general and special markets. The American methods have grown up as a matter of routine, and are adapted only to one class of

demand. There are, however, many modes of preparation which can be made use of to meet the wants of new markets, and thus enter more efficiently into competition with European nations for European trade, as well as for that of the West Indies and South America.

A great advance has already been made toward this desired improvement since the Centennial Exhibition of 1876, where many methods of curing and putting up fish were shown in the foreign sections that were almost entirely unknown in America. Notably among these were the preparations of sardines and other species of herring, in oil, as well as in spiced juices. Quite recently this industry has been well established in Maine, amounting to a value of millions of dollars, and there are many other parts of the country where the same work can be done with other kinds of fish. The whole subject is receiving the careful consideration of the Commission, and numerous facts bearing upon it have been announced in its reports and bulletins.

6. The work of increasing the supply of valuable fishes in the waters of the United States, whether by artificial propagation or by transplantation, although very successful, may be considered as yet in its infancy.

It must be remembered that the agencies which have tended to diminish the abundance of the fish have been at work for many years, and are increasing in an enormous ratio. This, taken in connection with the rapid multiplication of the population of the United States, makes the work an extremely difficult one.

If the general conditions remained the same as they were fifty years ago it would be a very simple thing to restore the former equilibrium.

At that time, it must be remembered, the methods of preservation and of wholesale transfer, by means of ice, were not known, while the means of quick transportation were very limited. Hence a small number of fish supplied fully the demand, with the exception, of course, of species that were salted down, like the cod, the mackerel, and the herrings (including the shad). At that time a comparatively small quantity supplied the demand for fresh fish, and it was easy to more than meet the demand. Now, however, the conditions are entirely changed. The whole country participates in the benefits of a large capture of fish, and there is no danger of glutting the market, since any surplus can be immediately frozen and shipped to a distance or held until the occurrence of a renewed demand.

Another impediment to the rapid accomplishment of the desired result is the absence of concurrent protective legislation of a sufficiently stringent character to prevent unnecessary waste of the fish during the critical period of spawning, and the erection or maintenance of impediments to their movements in reaching the spawning grounds. This is especially the case with the shad and the salmon, where the simple construction of an impassable dam, or the erection of a factory discharging its poisonous waste into the water, may, in a few years, entirely exterminate a successful and valuable fishery.

It is to be hoped that public opinion will be gradually led up to the necessity of action of the kind referred to, and that year by year a continued increase in the fisheries will be manifested. Even if this does not occur as rapidly as some may hope, the experiments so far furnish the strongest arguments in favor of continuing the work for a reasonable time. A diminution that has been going on for fifty or more years is not to be overcome in ten, in view of the increasing obstacles already referred to.

Among the species the increase of which in their appropriate places and seasons is to be hoped for, in addition to those now occupying the attention of fishculturists, are the cod, the halibut, the common mackerel, the Spanish mackerel, the striped bass or rock-fish, etc.

One of the most important and at the same time among the most promising fish is the California trout, with which it is hoped to stock large areas of the country. Its special commendations will be found mentioned elsewhere.

Another fishery earnestly calling for assistance, and capable of receiving it, is that of the lobster, the decrease of which has been very marked. The experiments of the Fish Commission suggest methods by which the number can be greatly increased. Something, too, may be done with the common crab of the Atlantic coast and its transfer to the Pacific. Some kind might also be advantageously brought to the eastern portion of the United States from the Pacific coast and from the European seas.

A subject of as much importance as any other that now occupies the attention of the Fish Commission is an increase in the supply of oysters. In no department of the American fisheries has there been so rapid and alarming a decrease, and the boasted abundance of this mollusk on the Atlantic coast, especially in Chesapeake Bay, is rapidly being changed to a condition of scarcity, which threatens practical extermination, as is almost the case in England. A fishing industry producing millions of dollars is menaced with extinction, and needs the most stringent measures for its protection.

The United States Fish Commission has been very fortunate, through its agents and assistants, in making important discoveries in connection with the propagation of the oyster, which are to be referred to hereafter; and it is proposed to establish several experimental stations for applying the discoveries thus made, so as to constitute a school of instruction and information to persons practically engaged in the business.

There are other shell-fish besides the oyster that will well repay the trouble of transplantation and multiplication. Among these are several species of clams belonging to the Pacific coast of the United States, which are much superior in size, in tenderness, and in excellence of flavor to those on the Eastern coast. Most of these are natives of Puget Sound, and the completion of the Northern Pacific Railway is looked forward to as a convenient means of transferring them to Eastern waters. The

common clams of the Atlantic coast are also fair subjects of experiment.

The continued increase in the correspondence of the Commission, referred to in the Report for 1881, has been very strikingly manifested during the year 1882, in which the number of official letters written (exclusive of filled blanks and circulars) amounted to over seven thousand as compared with fifty-six hundred in 1881. Letters received were over eleven thousand, nearly all requiring some attention. A large part of this correspondence is attended to by circulars, but as explained these are not included in the account of letters written during the year.

The new office of the Fish Commission (1443 Massachusetts avenue) has proved to be a very great convenience, allowing a much better classification of work and more ample accommodations for archives, records, drafting tables, etc. The building is fully occupied by the Commission, and in another year an additional story will be needed to meet expected requirements.

It is with great regret that I have to record the death, on the 22d of January, at an advanced age, of Mr. H. E. Rockwell, the secretary of the Commission, who had been connected with the Commission from its beginning, in 1871. At that time he was an employé of the Bureau of Education, but was enabled to give part of his time to the Fish Commission. In the course of the next year, however, his services were entirely engrossed by the Commission, and up to within a day of his death he was, with few exceptions, at his post, and actively engaged in his duties.

During the summer of 1881 he was seized with a slight paralytic attack, from which, however, he fully recovered sufficiently to resume his labor, after a few months interval.

Although not actually in the service of the United States Fish Commission, yet, as having been closely related to it by many years of correspondence and of hearty co-operation, I cannot omit referring to the loss which fish culture has experienced in the death of Mr. B. B. Redding, for many years one of the fish commissioners of California.

Mr. Redding was the pioneer of all the work done in the State in connection with the subject of fish culture; not confining himself to the ordinary routine, but busying himself in gathering in from all quarters whatever he thought might benefit the fishery interests of his State.

To him was due nearly all the important measures in connection with the State service, and notably the transfer of shad to the Sacramento River in 1876; of black bass and other eastern fresh-water fishes, and of striped bass, lobsters, tautog, etc.; the arrangement for keeping up the supply of salmon in the Sacramento River, with the aid of the United States Fish Commission; the preparation of ponds for the cultivation of the gourami, etc.

He personally superintended the transfer to California of the first stock of carp given to his State by the United States Fish Commission in 1879.

2.—PRINCIPAL STATIONS OF THE UNITED STATES FISH COMMISSION.

The stations of the Commission enumerated in the last report were, for the most part, occupied during the past year. It may, however, be well to enumerate them again. Classifying them as before, the list is as follows:

A.—INVESTIGATION AND RESEARCH.

1. *Gloucester, Mass.*—Capt. S. J. Martin, in charge of this station, continues his weekly reports of the products of the off-shore fisheries of that city, which have been collated and published from time to time in the bulletins of the Fish Commission.

Captain Martin visits every vessel on its arrival, and obtains the statistics of the catch during the voyage; and as there is no other organization for obtaining these data his figures are largely used in the market reports of the Boston and Gloucester papers.

Ever since the establishment of the Fish Commission station at Gloucester in 1878, the Commission has kept an office on Fort Point wharf for the collection of facts and specimens, and for constituting a convenient medium of communication between Captain Martin, the agent of the Commission, and the fishermen generally.

Some question having arisen as to the lease, the quarters in question were given up, and the work has since been performed by Captain Martin without any special headquarters.

2. *Wood's Holl, Mass.*—This continues to be the chief summer locality for investigation and research and the summer station of the vessels of the Commission.

The arrangements made for enlarging the work at this point will be more fully detailed hereafter.

3. *Saint Jerome, Md.*—This station is maintained for experiments in oyster culture, and the hatching of marine fish, especially of the Spanish mackerel. It was first established by Maj. T. B. Ferguson, as a commissioner of Maryland, but after a time was operated jointly by the Maryland and United States Commissions. On the 24th of April, 1882, however, it was formally transferred to the United States Commission, and the liabilities of the lease from Mr. John W. Wrightson assumed. All the property of the Maryland commission was purchased at a fair valuation.

B.—PROPAGATION OF SALMONIDÆ.

4. *Grand Lake Stream, Me.*—The propagation of the land-locked salmon is carried on here on a large scale under the direction of Mr. Charles G. Atkins.

5. *Bucksport, Me.*—The work of this station is primarily connected with the multiplication of Penobscot salmon, although 1,000,000 eggs of the whitefish sent from Northville, Mich., were hatched here and placed in Eagle Lake, on Mount Desert, at the request of Mr. Montgomery Sears.

6. *Northville, Mich.*—This establishment is principally concerned in

the hatching of whitefish, which are collected by Mr. F. W. Clark and his assistants, and at the proper time are either forwarded, in the condition of embryonization, to distant points or entirely hatched out and the minnows transmitted to suitable localities. The station is used also for breeding the Eastern brook-trout and the California trout, of which a good stock is maintained. A supply of carp is also kept here for distribution to convenient localities.

7. *Alpena, Mich.*—This is a new station, established during the present year, for the whitefish service, as being conveniently near the best localities for taking the eggs. It is kept as a feeder to the Northville station, which is the main one.

8. *Baird, Shasta County, California.*—This station, on the McCloud River, is devoted exclusively to the cultivation of the California salmon, for which it is eminently adapted.

9. *Trout ponds near Baird, Shasta County, California.*—This locality, situated about 5 miles from the salmon station, is devoted to keeping up a large stock of California trout to supply eggs for Eastern waters. The wild character of the region may be readily understood from the fact that the trout are fed on the meat of the black-tailed deer, as being the cheapest food that can be supplied to them.

C.—Propagation of Shad.

10. *Havre de Grace, Md.*—The transfer of work from barges anchored in Spesutie Narrows to an artificial island situated near Havre de Grace has vastly increased the facilities for fish propagation, and it is expected that when the station is completely equipped an enormous addition to the number of shad produced will take place.

11. *Washington, Central Station.*—This station, established in the old armory building, was greatly extended in its scope in 1882, and now constitutes the principal point, both for hatching shad and several other fish, and for their distribution by cars to distant parts of the country.

12. *Washington Navy-Yard.*—Work at the navy-yard is prosecuted by permission of the Navy Department and the courtesy of the commandant of the Yard.

13. *Avoca, N. C.*—This station was not maintained during the present year, but was occupied by the North Carolina fish commission with great success.

D.—Propagation of Carp.

14. *Monument Reservation, Washington.*—This is the principal station for the production of carp. The varieties cultivated are the leather and mirror carp. Golden ide and tench are also raised in considerable numbers.

15. *Washington Arsenal Grounds.*—Cultivation at this station is confined to the scale carp.

Fuller details in regard to the work and results of all these stations will be found under the head of the specific work for which they are maintained.

3.—VESSELS OF THE UNITED STATES FISH COMMISSION.

A.—The Steamer Albatross.

In the report for 1881 mention is made of the appropriation of $103,000 by Congress for the construction of a steamer, to be named the Albatross, and to be used by the Fish Commission in investigating questions connected with the fisheries of the high seas. Allusion was also made to the application to the Secretary of the Treasury to take charge of the building of this vessel, and his assignment of the duty to the Light-House Board, which had so ably supervised the building of the Fish Hawk.

As stated, also, in that report, the appropriation made was below the lowest bid, and consequently nothing was done until Congress could be asked for an additional allowance.

This, amounting to $42,000, was made on March 6, 1882, and as the first bids were inoperative competition was again invited, and on August 7, 1882, another appropriation was granted for supplying the vessel with anchors, chain, furniture, apparatus, &c., amounting to $45,000.

Other things being equal the considerations determining these bids were, first, the total amount; and, secondly, the time of completion.

Only three bids were received ; as follows: Pusey & Jones, Wilmington, Delaware, $135,000, in six months; Ramsay & Co., Baltimore, $144,000, in twelve months; Malster & Rainey, Baltimore, $145,000, in nine months.

The bid of Pusey & Jones being the lowest, and offering the shortest period for completion, was accepted; especially as their work on the Fish Hawk proved entirely satisfactory to the Commission; and a contract was promptly made, and the work commenced.

On March 15 the Secretary of the Navy assigned Lieut. Z. L. Tanner, commanding the Fish Hawk, to the additional duty of superintending the construction of the Albatross; and on March 29, Passed Assistant Engineer G. W. Baird was ordered to superintend the building of her machinery, receiving a final detail to the vessel on the 31st of March.

Although still in command of the Fish Hawk, Captain Tanner made repeated visits to Wilmington for the purpose of inspecting the progress of the work; until on the 4th of November he was detached from the Fish Hawk, and, on the 10th, ordered to the command of the Albatross, taking charge of the work on the 11th.

Owing to causes beyond their control, Messrs. Pusey & Jones needed an extension of the time of completion of the vessel, which was accordingly granted by the Secretary of the Treasury until the 1st of November, and again extended until December; the delay being caused mainly by the difficulty experienced in getting certain apparatus ordered directly by the Commission as part of the equipment.

The vessel was launched on the 19th of August, and work was prosecuted rapidly, with the interruptions mentioned.

Paymaster G. H. Read, of the Fish Hawk, was ordered to the additional duty of paymaster of the Albatross on November 4.

The vessel was put in commission when Captain Tanner reported for duty, and was supplied with the necessary officers and men by successive detail. The vessel left Wilmington on a trial trip for Washington on December 30, arriving on the 1st of January, 1883. The workings of the machinery were carefully studied, and the vessel taken back to Wilmington for final completion.

The *personnel* of the Albatross, on arrival at Washington, was as follows: Lieut. Z. L. Tanner, commanding; Lieut. Seaton Schroeder; Lieut. S. H. May; Lieut. A. C. Baker; Lieut. C. J. Boush; Ensign R. H. Miner; Paymaster George H. Read; Engineer G. W. Baird; Surgeon J. H. Kidder.

According to the measurements of the collector of customs at Wilmington, Del., by order of the Secretary of the Treasury, the gross tonnage is 625.20; net tonnage, 385.82; displacement, about 1,000 tons.

Her signal letters, as borne on the books of the Treasury Department, are G. V. Q. B.

A full description of the Albatross and of her equipment will appear in a subsequent report.

B.—The Steamer Fish Hawk.

The Fish Hawk continued in active service during the year; partly in connection with the hatching of shad, and partly in deep-sea exploration, with Wood's Holl as a base.

The details of her work will be found under other heads; though it may be mentioned, in general, that after remaining in the navy-yard in Washington during the winter she made an exploring trip in Chesapeake Bay.

The vessel left Washington on February 25, having on board in addition to her usual equipment a large number of gill-nets of various kinds, among which may be mentioned nets for herring, Spanish mackerel, menhaden, shad, whitefish, and cod. One object of the cruise was to set these nets in various parts of the Chesapeake and its tributaries, to ascertain if shad or any other of the anadromous fishes which visit these waters periodically, generally at a somewhat later date, might not be taken in the "deep holes" that occur in certain localities before they made their appearance in the shallow waters off the fishing stations.

The work of research on this occasion was in charge of Capt. J. W. Collins.

Nets were set opposite Point Lookout in 5 fathoms of water, off Barren Island in 20 fathoms, at the mouth of the Patuxent, off Smith's Point and Point Lookout, at Tangier Sound, off Cherrystone, and at the mouth of York River. The results obtained at either of these places were chiefly of a negative character. A few young menhaden were cap-

tured off Barren Island, and a number of dogfish (*Squalus acanthias*) were taken in the nets set off Cherrystone.

Dredgings were made with the beam trawl off Barren Island in 25 fathoms of water, but the captures consisted only of a few young menhaden, some young herring (alewives), and another small fish, besides a single crawfish, a few shrimp, and a limited number of small shells. Another set of dredgings off Cherrystone produced little besides a few specimens of skate (*Raia*, of possibly two varieties). The satisfactory prosecution of these researches were somewhat interfered with by the prevalence of strong winds and tides. It frequently happened that the combined force of the seas and currents drifted the nets from the positions where they were set, and in some instances the apparatus was seriously injured by contact with the bottom, or by drifting afoul of the net anchors as the gear was swept along. It was evident, however, that there were no shad in the localities visited, and, therefore, though the results obtained by the expedition were of a negative character, they were, nevertheless, of considerable value in establishing more definitely than we knew before the date of arrival in the Chesapeake of certain varieties of fishes, while it may, perhaps, be considered settled that no shad, herring, etc., remain inside the capes of Virginia in winter.

Experiments were also made on the cruise to ascertain what might be done in hatching cod-fish eggs in water taken from the Chesapeake. Just before the ship sailed from Washington 1,000,000 cod-fish eggs (about 75 per cent. of which appeared to be alive) were put on board, these eggs being in artificial sea water. Upon arrival at Point Lookout the eggs were put in a glass jar and three cones, and the hatching process begun. That was on Saturday, and the following Monday morning few eggs remained alive, probably not more than one in five hundred, while none had advanced any in development since being placed in water taken from Chesapeake Bay, the density of which was found to be 1.0070, while that of sea water is from 1.0240 to 1.0290. The eggs sunk to the bottom of the hatching apparatus, when put into the water obtained at Point Lookout, and it was not long before examination showed the germinal disk to be much distorted. On Tuesday morning no eggs remained alive, and the embryos that lived the longest were much more misshapen than others which died earlier.

After returning from Chesapeake Bay, the Fish Hawk proceeded to Quantico, Va., on the 10th of April, to carry on the hatching of shad and herring.

On the 7th of July she proceeded to Wilmington with a load of machinery and supplies for the Albatross; and on the 16th of that month was ordered to New Haven to await further orders.

She returned to Washington on the 21st of July, and took on board the usual apparatus and material for Wood's Holl, and left for that station on the 24th, arriving on the 26th.

Several trips were made by her to the Gulf Stream; namely, on the

1st, 10th, and 25th of August, 6th of September, and 3d and 12th of October.

Returning, she arrived in New York on the 20th of October, reaching Washington on the 29th.

On the 20th of November, after the transfer of Lieut. Z. L. Tanner to command the Albatross, Lieut. William M. Wood was transferred from the Lookout to command the Fish Hawk. She was then at the Washington navy-yard, undergoing slight repairs, remaining there until the end of the year.

The *personnel* of the Fish Hawk, at the close of the year, was as follows: Lieut. William M. Wood, commanding; engineer, W. L. Bailie; mate, James A. Smith; mate, C. H. Cleaveland; apothecary, J. Allen Kite, who succeeded Dr. Van Vliet on the resignation of the latter.

C.—The Lookout.

The small yacht steamer Lookout has been constantly occupied during the year in the service of the Commission on the Potomac, on Chesapeake Bay, on the Susquehanna River, and at Wood's Holl.

Up to November she was in command of Lieut. William M. Wood, but when this officer was transferred to the command of the Fish Hawk she was placed in charge of Quartermaster Hamlen.

Her most important operation will be found mentioned under the head of the "propagation of shad," as being engaged in transporting the eggs from the river stations to the hatching houses.

D.—Launch No. 82.

The service of several steam launches is always required in the work of the Commission, especially in connection with the propagation of the shad, for collecting the eggs from distant points, and transferring them to the proper stations.

The Navy Department very kindly furnished the Commission with two launches, as heretofore, namely, Nos. 49 and 55; but an additional one being required, Launch No. 82, subsequently christened the Cygnet, was purchased from the Herreshoff Manufacturing Company, and put immediately into use. This boat, about 33 feet long, was found in every way to answer a satisfactory purpose.

E.—The Canvas Back.

The laying out of the large shad seine at Battery Station, Havre de Grace, requires an extended force of men. For the purpose of economizing the number, plans were prepared for a very light draft steamboat, sufficient to take on board the seine and carry it out over the flats, thus enabling the work to be done in a better manner by a very few persons.

Drawings for a suitable vessel were made under the direction of Maj.

T. B. Ferguson, and estimates obtained from several builders, notably the Herreshoff Manufacturing Company, Pusey & Jones, &c. The cost, however, was much greater than the available funds of the Commission would admit, and the subject was necessarily deferred for a future occasion.

4.—TRANSPORTATION AND HATCHING CARS.

Reference has already been made to the adaptation of a baggage car of the Philadelphia, Wilmington and Baltimore Railroad to the needs of the Commission in the transportation of young fish. For the sake of securing proper attention to this car by railroad companies, it was, by permission, labeled "Pennsylvania," as if belonging to the Pennsylvania Railroad Company.

A second car, authorized by Congress, was built entirely for the Commission by the Baltimore and Ohio Railroad Company, and labeled "Baltimore and Ohio, No. 2, United States Fish Commission."

The entire bill of the railroad company for the construction of this car complete and ready for use amounted to $7,218.55, although some additional expense was incurred in adapting the special fish transporting apparatus, the total cost amounting to about $8,000.

This car was built under the supervision of Mr. F. S. Eastman, and according to a form of trussing patented by him. It offered special advantages in the way of strength and lightness.

The measurement of these cars is as follows: Length of car No. 1, 51 feet 2 inches without platform; with platform, 57 feet 6 inches; total height from the track to the topmost projection, 14 feet 1½ inches; total width 9 feet 10 inches.

The dimensions of car No. 2 are, length from out to out of buffers, 59 feet 9 inches; total width, 10 feet; height from top of track to top of hood, 14 feet ⅞ inches.

Work upon this car was begun about the 13th of March, and on the 24th of May it was received, completed, from Baltimore. The first trip made by it was with a load of carp, on the 4th of November.

Further details of the uses of these cars will be found under the special heads.

5.—COURTESIES EXTENDED TO THE UNITED STATES FISH COMMISSION.

As in previous years, I have the pleasure of acknowledging many important courtesies extended to the Commission by the various Departments of the Government, by railroad and steamboat companies, and by individuals. Indeed, without the help thus rendered it would be quite impossible to carry on the work on its present scale, without a very considerable increase in the appropriations.

THE TREASURY DEPARTMENT.—*The Secretary's office.*—On the occasion of the expected arrival of certain collections of fish from abroad the Secretary of the Treasury directed the collector of customs at New

York to render every facility for their speedy transfer from the vessel to the cars of the Commission.

Light-House Board.—The valued service rendered for so many years by the Light-House Board in authorizing the use of the buoy station at Wood's Holl as a central station of operations has been continued, during the year, and the quarters originally fitted up by the Commission in 1875 were occupied for the third time.

The Board also continued its assistance in forwarding blanks and thermometers furnished by the Commission to various light-ships and light-houses, and in collecting and forwarding returns. The importance of this co-operation on the part of the Board cannot be overestimated, as it enables the Commission to reach a class of intelligent men whose opportunities for observation are of course unrivaled.

The Board has also kept the Commission and its vessels fully supplied with lists of stations and other documents for use in connection with the navigation of the coast.

The Coast Survey.—The Coast Survey has met promptly all demands upon it for maps and charts required for the service of the vessels of the Fish Commission.

THE WAR DEPARTMENT.—*Engineer Bureau.*—The co-operation of the War Department has been exhibited, through the Engineer Bureau, in connection with the work of river and harbor improvements in the vicinity of the stations of the Commission at Havre de Grace, Saint Jerome, and Wood's Holl. A considerable amount of work was done by the Bureau in the improvement of the channel and the approaches to the Havre de Grace and Saint Jerome's stations, adapting them more particularly to the operations of the Commission; the cost being defrayed partly, where this could legitimately be done, from the appropriations for rivers and harbors, and partly from those of the Commission.

The Signal Office.—As heretofore, the Chief Signal Officer has been always ready to co-operate in the scientific work of the Commission, especially in securing records of temperatures of river and sea waters. What he has done in the past will be found fully acknowledged in previous reports, and the records of 1882 show a continuance of his favor. In addition to supplying a full set of meteorological apparatus for the station at Havre de Grace, and less complete series for the steamers of the Commission, he has furnished the greater portion of the thermometers supplied to light-ships and light-houses.

NAVY DEPARTMENT.—The assistance of this Department has from the very beginning been of the utmost moment to the Commission in nearly all branches of its operations. The officers and crew of all the vessels of the Commission are furnished by the Navy Department, including those of the Albatross, the Fish Hawk, the Lookout, and the launches; while all the facilities of the navy-yards, especially that of Washington, have been freely extended.

The *Engineer Bureau* ordered a board to inspect the boiler of the Lookout and to determine the question of repairs necessary to put it in proper commission.

The *Bureau of Construction* placed at the disposition of the Commission two serviceable steam launches (Nos. 49 and 55) for the work of the shad season of 1882.

The *Bureau of Equipment* furnished a number of articles for the equipment of the Albatross.

The *Bureau of Navigation* met all the applications of the Commission for detail of officers in the most cordial spirit, making selections with special reference to the duties to be performed.

The *Bureau of Ordnance* issued a breech-loading gun to the Albatross, and also a number of obsolete powder tanks to be used in making collections of natural history.

THE COMMISSIONER OF PUBLIC BUILDINGS AND GROUNDS.—Col. A. F. Rockwell, the Commissioner, authorized the inclosure of the Armory grounds by a fence, for the better protection of the property of the Commission, and also permitted the construction of a large shed for the storage of packages that could not be conveniently accommodated within the armory.

THE RAILROADS OF THE UNITED STATES.—The various railroads throughout the country have continued to assist in the work of the Commission with the same liberality as before. They have continued their agreement with the Commission to transport fish in the baggage cars of passenger trains without extra charge, allowing the messengers free access to them, as shown by the accompanying list. This privilege has not been of so much importance as in previous years, owing to the much more extended adoption of the system of forwarding the fish either in the transporting cars of the Commission or in those chartered for special trips.

As explained in earlier reports, a special rate has been adopted by most of the roads for this service; this, for the most part, being 20 cents a mile for the transportation of the car on passenger trains, to include the fares of five messengers—any number above this paying the regular passenger fare. This arrangement, first established through the assistance of President Hinckley, of the Philadelphia, Wilmington and Baltimore Railroad, on his own road, and next extended to the Pennsylvania and the Baltimore and Ohio roads, has since become almost universal throughout the country; so much so, indeed, that very little difficulty is experienced in sending the car in any desired direction. In some cases, even, the car is carried without any charge whatever for transportation and messengers, or else at rates below that of 20 cents per mile. In a few cases the charges have been greater than 20 cents; but in nearly every instance there has been an important reduction.

The acknowledgments of the Commission are most especially due for

gratuitous service of the nature mentioned, to the Eastern, Maine Central, and British and North American roads of New England, and the Provinces.

One important consideration in asking from the roads the facilities in question is found in the fact that an appropriation in lump is made by Congress in the interest of the community, and that whatever reduction of cost can be accomplished allows a greater expenditure in some other direction. Twice the amount of the annual appropriation could readily be used; and as the number of streams and ponds to be supplied with fish is of enormous extent, requiring many years, even on the most liberal scale of operation, before they can all be provided for, a selection is, of course, necessary, and is usually made along the routes of greatest co-operation on the part of the transportation companies. There is nothing invidious in such a selection; and as the railroad companies are interested in the prosperity of the regions traversed by them, they feel justified in drawing the action of the Commission in their direction.

I may also mention that the Pennsylvania and the Old Colony Railroad companies prepared special tickets facilitating the transportation of the officers and employés of the Commission to and from Wood's Holl.

While making the acknowledgments of the United States Fish Commission to the railroads for service rendered, what the latter do in the interest of the work of the fish commissioners of the several States should not be overlooked.

In most instances where an active body of State fish commissioners is at work, they can obtain, with little or no difficulty, free passes while on official business, and free transportation for their fish. In a number of the Western States the commissioners devote special attention towards gathering up fish that have been stranded by overflows of the rivers or otherwise dangerously situated, and returning them to the channel; many millions of the most valuable varieties being annually thus saved.

Most of the State work in question has been performed in Virginia, North and South Carolina, Georgia, Illinois, Ohio, Kansas, Iowa, etc.

It would be invidious to mention the railroads, as I am not aware that any application has yet been refused.

FOREIGN STEAMSHIP COMPANIES.—Assistance has also been rendered the Commission during the year by the various steamship companies, particularly the Cunard, the French Transatlantic, and the North German Lloyds, as will be referred to hereafter.

BY OTHER PARTIES.—Mr. Paul Schultz, of Oregon, of the Northwestern Trading Company, offered free transportation to any one who might be sent out by the Commission to study the fisheries of Alaska. I hope to be able to make use of this proposition at an early date.

6.—COURTESIES TO FOREIGN COUNTRIES.

Almost from the very beginning the United States Fish Commission has endeavored to increase the scope of its work by securing any of the varieties of fish from foreign countries that promised to be useful in North America.

Among its efforts in this direction may be mentioned the improved varieties of German carp, the Rhine salmon, the European whitefish and trout, the tench, the ide, the turbot, the sole, and other species. Most of these have been supplied without any charge whatever by foreign governments or fish-cultural institutions, and the United States Fish Commission, desirous of doing its part in the exchange of products, has taken great satisfaction in meeting applications from its correspondents abroad for similar contributions.

In previous reports will be found detailed statements of what has been done in past years in the way of transmitting shad, land-locked salmon, whitefish, California trout, lake trout, black bass, etc., and this international courtesy has been continued during the year 1882 as follows:

France.—On the 14th of January 250,000 eggs of the whitefish and 20,000 eggs of the brook trout were forwarded to the Société d' Acclimatation in Paris, and their arrival in good condition was acknowledged on February 17. On the 4th of March a successful shipment of 10,000 eggs of the land-locked salmon was made to the same country.

Germany.—A large number of eggs of land-locked salmon, lake trout, California trout, and whitefish were forwarded *via* Bremen to the Deutsche Fischerei-Verein, arriving in good condition. Subsequently 10,000 eggs of land-locked salmon were sent to Mr. Ebrecht. On the 29th of April 2,000 eggs of the California trout, (*salmonidæ*) were forwarded to the Deutsche Fischerei-Verein.

Great Britain.—At the request of Mr. George Sheppard Page, thirty-three black bass were sent to the Duke of Sutherland on the 31st of May, of which thirty-one arrived safely. These were placed on April 20 in Loch Brora, a lake six miles long and well suited to the growth of fish.

Chili.—In reply to the application of the Chilian minister in Washington, information was supplied in regard to the more important food-fishes of the United States, and especially the carp. The necessary pamphlets and instructions were furnished for their cultivation, and a promise was made of as many young fish at the proper time as could be conveniently transported.

7.—FISHERY EXHIBITIONS.

It has been my duty to report participation by the United States Fish Commission in two fishery exhibitions—one in Philadelphia, and the other in Berlin. Numerous invitations have been extended to take part

in others—notably those at Norwich, England, in 1881, and Edinburgh, in 1882. As these were occasions of minor importance, the invitations to participate, unaccompanied, as they were, by formal action of the British Government, were not responded to. The exhibitions were held during the years mentioned, and were very successful in exciting interest to the subject of fish culture and the fisheries; so much so, indeed, that it was determined to hold a much larger and more comprehensive exposition in London in 1883. This enterprise soon assumed an international importance, and a formal invitation was extended by the British Government to the United States to take part on this occasion.

The correspondence began by the transmission, on the part of Minister Lowell, of an inquiry from the Earl of Ducie as to whether an invitation to the United States of participation would be received favorably. On the 26th of April the President transmitted to Congress a message on the subject, recommending acceptance of the invitation and an appropriation to carry out its requirements. A bill appropriating $50,000 was reported by the Committee on Foreign Relations of the House, was passed under suspension of the rules, and was concurred in by the Senate on the 13th of July.

On the 3d of May I appeared before the House Committee on Foreign Relations, and on the 26th of May before the Senate committee, explaining the character of the proposed exhibition, and the advantages that the United States might be expected to derive in consequence of her participation.

As soon as the money became available preparations were made for the occasion, and a careful investigation was made as to suitable objects in the National Museum. The deficiencies were then noted, and measures taken to supply them. It was considered particularly desirable to furnish a complete series of models, illustrating the progress of the American fishing vessels from their earliest forms to those of the present day. Preparations were also made for securing all the later and better varieties of tackle and other fishing apparatus of every kind. Small boats, sportsmens' clothing and equipment, samples of the various fishery productions, casts of fishes, fish-hatching—and fish-curing establishments of the country, etc. It was determined also to secure an extensive series of photographs, illustrating everything connected with the fishery industries.

The gentlemen who had been so successful in collecting the statistics for the census department of the fisheries was again assigned to this new service, especially Messrs. J. W. Collins, R. E. Earll, H. C. Chester, A. Howard Clark, and others. Mr. Elliott, as artist, and Mr. Smillie, as photographer, visited the fishing localities, and made many sketches and pictures and photographs (mostly instantaneous) of much interest. The whole work was under the direction of Mr. G. Brown Goode, assisted, so far as fish culture was concerned, by Major Ferguson, Colonel McDonald, and other specialists of the Commission. Models and maps of the various

fish-hatching establishments of the Commission, with detailed statistics as to their history and management, were prepared. These, however, will be presented more in full in the report for 1883.

It may be stated, in passing, that the time of opening of the exhibition was fixed for the 1st of May, 1883.

By way of experiment as to the possibility of forwarding the well-known painted casts of fish which adorn the National Museum, a box containing a number of them was packed and forwarded to Mr. Wesley, the London agent of the Smithsonian Institution, with instructions to return it unopened. No particular injunctions were given as to the care of the box and its contents; and on its return, some weeks after, the casts were found to be in perfectly good condition, thus giving much encouragement in regard to forwarding a complete series.

Among other special preparations that were made for the occasion, Mr. Lindenkohl, of the Coast Survey, was commissioned to prepare a model of the sea-bottom of the Gulf of Maine, on a scale of $\frac{1}{400000}$. This was intended to exhibit all the principal fishing banks of the region between Eastern New England and Nova Scotia. When completed it was, by permission, exhibited by the Coast Survey, at the Garfield Fair held in Washington in November.

The Commissioner of Patents undertook to bring together a complete series of all the patents which had been issued in connection with fishing and the fisheries during the century. This was done, and the collection filled three stout volumes.

The Superintendent of the Life-Saving Service also took great interest in making a display of apparatus connected with his work.

With the preparations made by the Commission for the London Exposition of 1883, it is hoped that the next report will chronicle as great success on the part of the United States Fish Commission as occurred at Berlin in 1880.

8.—PUBLICATIONS IN 1882.

The most important publication upon which the Fish Commission was engaged in 1882 was the printing of a portion of the Annual Report for 1880, which was, however, not actually completed until 1883.

In the report for 1881 mention is made of the action of Congress in authorizing the printing, annually, of a bulletin of the Commission, to contain notes of discoveries and improvements in fish culture and fisheries, whether made by the Fish Commission itself or by other parties.

The first volume (for 1881) contained a great deal of interesting matter, and was completed in July, 1882, but the second volume for 1882 was more important, as serving as a medium for the immediate publication of interesting facts and suggestions connected with the work of the Commission. It was commenced in August, 1882, and a large portion was printed by the end of the year.

For various reasons it has usually been impossible to get out the full report of the Commission until the second year after date, or even later;

and as the Bulletin is published signature by signature, and distributed in this form, a discovery can be announced within a few weeks after it is made.

About two hundred copies of the Bulletin of 1882 were distributed by signatures to specialists, to State fish commissioners, and to the more important scientific societies, thus giving them the advantage of early knowledge of their contents. The remainder of the edition is distributed by volumes, mostly to the parties receiving the Annual Report.

This work is a public document, and from the large edition printed, Congressmen have copies at their disposal for their correspondents.

A small pamphlet containing the rules and regulations of the Fish Commission for the government of its employés, together with a summary of the Treasury and other Government regulations in regard to the keeping of accounts, was published and distributed to all parties interested in 1882.

Large numbers of circulars required for the current business of the Commission have also been printed and distributed.

Five fishery bulletins prepared by the Commission have been printed by the authorities of the Census Bureau of 1880, and will be found enumerated in another part of this report. These were in continuation of the joint arrangements between the United States Fish Commission and General F. A. Walker, Superintendent of the Census, to which reference is made in another place.

In view of the great delay in getting out the Census publications, authority was asked of Congress to print a special series of reports in quarto that had been contemplated or prepared for the Census, and, accordingly, a joint resolution was passed, as follows:

Resolved by the Senate (*the House of Representatives concurring*), That the Public Printer be, and is hereby, instructed to print in quarto form a report by the United States Commissioner of Fish and Fisheries upon the food-fishes and the fisheries of the United States, the engraving to be in relief, and to be contracted for by the Public Printer, under the direction of the Joint Committee on Printing, and to receive the approval of the Commissioner before being accepted; the work to be stereotyped, and 10,000 extra copies printed, of which 2,500 shall be for the use of the Senate, 5,000 for the use of the House, and 1,500 for the use of the Commissioner of Fish and Fisheries. There shall also be printed 1,000 extra copies for sale by the Public Printer, under such regulations as the Joint Committee on Printing may prescribe, at a price equal to the additional cost of publication, and 10 per cent. thereon added.

Work was immediately begun on this series, and before the end of the year a large part of the first volume, on the natural history and food-fishes of the United States, was in the hands of the printer, and to a considerable extent was stereotyped.

A large number of drawings was also made for the plates, and some of them reproduced by the photo-engraving process.

The volume will probably appear in the course of the year 1884.

Mr. Charles W. Smiley, Chief of the Division of Records, has had en-

tire charge during the year of the preparation of all matter for the printer, the correcting of the proofs of text and plates, and all else relating to the proper presentation of the several volumes, pamphlets, and circulars as well as of their distribution to correspondents and applicants.

9.—PAYMENTS FOR ROYALTIES.

The question has frequently arisen on the part of the Commission as to the payment of royalties on patented articles used in connection with its operations, especially those of fish culture; the particular question being the demand of Mr. Oren Chase, of Detroit, for compensation for the alleged use of the principle of his fish-hatching jar. There is no question of authority to purchase an instrument or object, with the understanding that the price includes the royalty; but, in this instance, waiving the question of actual infringement of the patent, inquiry was made of the First Comptroller as to the authority to grant, under the circumstances, the request of Mr. Chase. After a careful consideration of the subject, he decided that the claim of Mr. Chase was of the nature of damages against the United States, and that the only remedy was in an application to Congress for compensation.

10.—PERMANENT SEA-COAST STATION OF THE UNITED STATES FISH COMMISSION.

From the inception of the work of the Commission, in 1871, it has been the custom to select some station on the sea-coast from which to prosecute the researches required by Congress into the scientific and economical problems connected with the sea and its inhabitants; the stations, as already indicated, covering the coast from the Bay of Fundy to Long Island Sound. In this way the peculiarities of the in-shores have been well determined, and the geographical distribution of the fishes, mollusks, crustaceans, radiates, etc., properly marked out. In addition to the discovery of a great many new species, much light has been thrown upon the subject of marine natural history generally.

It is not to be supposed that everything in this connection has been learned; but the broad features have been determined, and the remainder can be safely left to local and special researches.

The acquisition of a sea-going steamer, in the Fish Hawk, and the hope of obtaining a still more serviceable vessel, rendered it expedient to fix upon some point for permanent occupation where the necessary facilities could be obtained for doing the work of the Commission in the best manner.

As the same station was to be used, both for research, and for propagation of the marine fishes, and as the best conditions for the latter were found on the south coast of New England, fish here being in greater variety, and, so far as the winter hatching was concerned, the cold being much less severe, and the other circumstances generally more favor-

able, the region last mentioned was fixed upon. Although, so far as codfish are concerned, the fish are nearer the eastern coast of New England, still, by the use of a suitable fishing smack, they can be brought in alive from any reasonable distance and penned up until needed, and in this way exposed to much less danger from destruction by cold than was found to be the case when such work was prosecuted in Gloucester.

After a careful consideration of the subject, the choice was found to lie between two stations, Newport and Wood's Holl. Newport is much the more convenient of access, and its citizens manifested a great desire to secure the presence of the Commission. A committee, of which Mr. J. M. K. Southwick was spokesman, offered to furnish the necessary buildings and also the use of a suitable wharf, and otherwise to encourage the selection of that station. The Navy Department also gave the Commission a provisional invitation to establish itself on the northern end of Coasters' Harbor Island, a portion thought not to be required for the purposes of the Naval Training School. The great objection was found to be the comparative impurity of the water of Narragansett Bay, receiving, as it does, the drainage of a number of large cities, as Newport, Fall River, Bristol, Providence, etc., and having a large area of muddy bottom.

The experience of the year 1880 showed that the sediment settling, as it would, upon the eggs of the fishes to be hatched out, would materially impair their development, as was the case at Gloucester.

A totally different condition of things was found at Wood's Holl, where the water is exceptionally pure and free from sediment, and where a strong tide, rushing through the Wood's Holl passage, keeps the water in a state of healthy oxygenation specially favorable for biological research of every kind and description. The entire absence of sewerage, owing to the remoteness of large towns, as well as the absence of large rivers tending to reduce the salinity of the water, constituted a strong argument in its favor, and this station was finally fixed upon for the purpose in question.

The quarters occupied by the Commission at Wood's Holl, furnished by the courtesy of the Light-House Board, were too scanty for the enlarged work contemplated by the Commission, and measures were immediately instituted to obtain a foothold on the Great Harbor. Here a point of land, constituting the neck of the upper harbor, was fixed upon as a suitable location, affording the advantage of very deep water, accessible to vessels of ordinary dimensions, and immediately adjacent to the rapid tide of the passage. Negotiations were opened with the owners of the ground, Messrs. Isaiah Spindel & Co., and a provisional agreement made as to the price and the conditions of the purchase as referred to in the report of 1881.

The subscriptions of the various parties, to enable the Fish Commission to purchase the land at Wood's Holl required for the purpose of a

permanent fish-hatching and research station, and the donation of a large tract by Mr. J. S. Fay, were, of course, contingent upon the appropriation by Congress for the adjacent pier, and although this appropriation was made in 1882, it was not considered proper to call in the subscriptions and to definitely acquire possession of the money.

Mr. C. F. Choate, president of the Old Colony Railroad Company, and Mr. J. Malcolm Forbes, a summer resident of Naushon, were selected as trustees to whom the land was to be conveyed by the owners, Messrs. Isaiah Spindel & Co. and Mr. Joseph S. Fay, whenever the circumstances warranted it, the deeds of cession being made to the trustees with the proviso that on the claim either of the United States Fish Commissioner or of the Secretary of the Treasury there should be a transfer of the property to the United States.

As no permanent acquisition of ground can be made or accepted by the United States, unless full jurisdiction over the same (with the usual limitations) is ceded by the State, a resolution to that effect was accordingly passed by the legislature, and became a law by the signature of Governor John D. Long on March 30, 1882.

A general law was already in existence, authorizing the governor, without further formality, to cede jurisdiction over ground acquired by the United States Government for light-house purposes, custom-houses, or post-offices, and the Fish Commission was included with the parties specified. Thus, in case of future acquisition of land, it is only necessary under the law to make application to the governor for the cession thereof, and compliance with the requirement that a proper designation and plot of the tract be filed within a year of the receipt from the governor of the necessary documents. It is understood that this jurisdiction does not exclude the State officials from entering upon the land to serve a civil or criminal process.

It was suggested, in view of the expected acquisition and improvement of the ground at Wood's Holl for Government purposes, that the buildings which had been erected by Professor Agassiz on the island of Penekese in 1873, and which, since the abandonment of the island to its original owner, Mr. Anderson, had been unoccupied, might be properly transferred to Wood's Holl. I accordingly visited the locality for the purpose of making the necessary examination, but satisfied myself that, even if the buildings could be obtained free of cost, it would not be expedient to use them in the new station, the general requirements being so totally different, and the requisites not met by the buildings in question.

In order to possess data necessary for intelligent calculation in reference to grading and filling the Wood's Holl property, I secured the services of Mr. E. W. Bowditch, a well-known landscape architect and engineer of Boston, to make a careful survey of the premises. This he accordingly did and furnished a map on the scale of 20 feet to the inch,

with contour lines 1 foot apart over the entire surface of the greater part of Bar Neck. A reduced map of this, but somewhat extended in area, was made without contours, on a scale of 50 feet to the inch, corresponding in this respect to the scale of the hydrographic survey of the adjacent shores made by General Warren in 1881.

11.—CONGRESSIONAL ACTION IN REGARD TO THE WOOD'S HOLL STATION.

As explained heretofore, the carrying out of the extended plan for using Wood's Holl for a great central station for hatching sea fishes, such as cod, halibut, etc., depends upon an appropriation in the river and harbor bill for the construction of a harbor of refuge in the great harbor of Wood's Holl, to consist of a hollow pier, serving first to cover up and mask a reef of dangerous rocks; secondly, to protect the upper portion of the great harbor, and thus permit vessels of 20 feet draft to come in and remain in perfect safety in severe storms; and, thirdly, to furnish the basins for keeping the live fish.

The subject of an appropriation for a harbor of refuge was brought before the River and Harbor Committee of the House, and all the arguments in favor of the proposition were duly presented and sustained by Representatives Candler and Crapo, of Massachusetts, and other gentlemen interested in the commercial aspect of the plan. The signatures of business firms and insurance companies representing a capital of between one and two hundred millions of dollars, together with those of masters of many coastwise vessels, were obtained by Mr. John M. Gliddon, and brought before the committee in support of the measure, and, largely through the intervention of the gentlemen mentioned, especially of Mr. Candler, who was a member of the committee, an appropriation of $52,000 was obtained.

The magnitude of the amount appropriated by the river and harbor bill induced the President to defer action upon any new items in it until the subject could be recommitted to Congress for its consideration, work already under way alone receiving attention during the year. This, of course, was a very unwelcome interruption to the general labors of the Commission and retarded the completion of the plan for one year. It is hoped, however, that the embargo on the expenditure for Wood's Holl will be raised during the year, and that the work will be completed in 1883–'84.

No new development has occurred in connection with the acquisition of land for the purposes of the Commission. The subscriptions made by the various parties referred to in the report for 1881 were available only in the event of an appropriation by the Government for the collateral objects, and this being deferred everything has been held in abeyance during the year.

B.—INQUIRY INTO THE HISTORY AND STATISTICS OF FOOD-FISHES.

Having thus passed under review the most important features of the general work of the Commission during the year 1882, I now proceed to present more definitely the operations connected with the so-called "Inquiry Division" of the subject, embracing all that relates to the investigation into the actual condition of the inhabitants of the waters and their mutual relationships, as well as to the statistics of their abundance and capture, and the methods and apparatus by which they are, or may be, rendered subservient to the requirements of man.

The other branch of this work of the Commission relates to the increase of the supply of food-fishes generally, or in particular localities, by means of artificial propagation or by transplantation.

The investigations connected with the first branch of inquiry may be considered under several heads to be taken up in their order.

12.—THE SENATE COMMITTEE ON INVESTIGATION OF THE MENHADEN FISHERIES.

The many complaints, by citizens of New Jersey, of the destruction of the menhaden by purse and pound nets involving an inability of the fishermen to secure sufficient bait for line fishing, as also the assertion that large numbers of valuable food-fishes were destroyed by these agencies, induced the reference of the several memorials and petitions to a subcommittee of the Senate Committee on Foreign Relations; this reference having been made on the ground that any legislation in regard to the inshore fisheries would necessarily have a very definite relationship to the provisions of the fisheries clause of the Washington treaty which went into effect in 1873.

The subcommittee named consisted of Mr. Lapham as chairman, with Messrs. Edmunds, Miller of California, Morgan, and Windom as members.*

The United States Fish Commission was instructed to render to this subcommittee any assistance in its power.

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*The following are the Senate resolutions under which action has been taken:

"*Resolved*, That five members of the Committee on Foreign Relations of the Senate be designated by the chairman of said committee as a subcommittee to act in conjunction with the Commissioner of Fish and Fisheries to examine into the subject of the protection to be given by law to the fish and fisheries of the Atlantic Coast, as proposed in the bill (S. No. 1823) for the protection of fish and fisheries on the Atlantic Coast.

"*Resolved*, That said committee have power to send for persons and papers in regard to the before-mentioned inquiries, and that it have leave to sit during the recess of the Senate.

"*Resolved*, That the expenses incurred in the execution of the foregoing resolutions be paid on the certificate of the chairman of said subcommittee out of the appropriafor the contingent expenses of the Senate."

The subcommittee took up its work immediately after the adjournment of Congress, and visited a number of the towns on the coasts of New Jersey, New York, Connecticut, and Rhode Island, taking a large amount of testimony from both sides in the controversy.

The Commission placed the Lookout at the command of the committee, and, at various times, Major Ferguson and Colonel McDonald, of the Commission, were in attendance and rendered such help as they could.

Quite a number of witnesses were examined in Washington, being summoned there for the purpose.

The subcommittee did not consider it expedient to make a report of its work for 1882, preferring to devote another session to the special inquiry.

13.—THE WORK OF THE FISHERY CENSUS OF 1880, AND ITS RESULTS.

In my report for 1879* it was announced that arrangements had been made to co-operate with the Superintendent of the Tenth Census in collecting the statistics of the fisheries of the United States. In subsequent reports the progress of the work has been frequently alluded to, and the principal features of the plan described.

The work is still in progress, the delay in printing the reports, although vexatious, affording an opportunity for a more careful elaboration of the material than would otherwise have been practicable. The alliance between the Census and the Fish Commission, so far as financial interests are concerned, having come to an entire close during the year, it seems appropriate to review at this time the history and present condition of the undertaking.

In July, 1879, an arrangement was made with General Francis A. Walker, Superintendent of the Tenth Census, by which an investigation of the fisheries of the United States was undertaken as the joint enterprise of the United States Fish Commission and of the Census Bureau. It was decided that this investigation should be as exhaustive as possible, and that both the United States Fish Commission and the Census should participate in its results. The preparation of a statistical and historical description of the fisheries, to form one of the series to be presented by the Superintendent of the Census in his report, was from the first the main object of the work, but in connection with extensive investigations into the methods of the fisheries, into the distribution of the fishing-grounds, and the natural history of useful marine animals were carried on.

The direction of this investigation was placed in the hands of Mr. G. Brown Goode, who was appointed a special agent of the Census Office,

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* Report of Commissioner. Part VII, 1879 (1882), pp. XXIII–VII. *Ibid.* Part VIII, 1880 (1883), pp. XXVII, 1–62. *Ibid.*, Part IX, 1881 (1884), pp. XXXI–II. Report of Secretary of Smithsonian Institution, 1880 (1882), pp. 78–9. *Ibid.*, 1881 (1883), pp. 51–3. *Ibid.*, 1882 (1883), p. 55.

and who has since been carrying on this work in addition to the performance of his duties in connection with the National Museum and the Fish Commission.

The plan of the investigation was drawn up before the beginning of the work, and was published in an octavo pamphlet of fifty-four pages, entitled "Plan of Inquiry into the History and Present Condition of the Fisheries of the United States." Washington: Government Printing Office, 1879; also, as above stated, in Part VIII of this report.

The scheme of investigation divided the work into the following departments:

I.—NATURAL HISTORY OF MARINE PRODUCTS.

Under this head was to be carried on the study of the useful aquatic animals and plants of the country, as well as of seals, whales, turtles, fishes, lobsters, crabs, oysters, clams, etc., sponges and marine plants and inorganic products of the sea, with reference to (A) Geographical Distribution; (B) Size; (C) Abundance; (D) Migrations and Movements; (E) Food and Rate of Growth; (F) Mode of Reproduction; (G) Economic Value and Uses.

II.—THE FISHING-GROUNDS.

Under this head were studied the geographical distribution of all animals sought by the fishermen, and the location of the fishing-grounds; while with reference to the latter are considered: (A) Location; (B) topography; (C) depth of water; (D) character of bottom; (E) temperature of water; (F) currents; (G) character of invertebrate life, etc.

III.—THE FISHERMEN AND FISHING TOWNS.

Here were to be considered the coast districts engaged in the fisheries, with reference to their relation to the fisheries, historically and statistically, and the social, vital, and other statistics relating to the fishermen.

IV.—APPARATUS AND METHODS OF CAPTURE.

Here were to be considered all the forms of apparatus used by fishermen, boats, nets, traps, harpoons, etc., and the methods employed in the various branches of the fishery. Here each special kind of fishery, of which there are more than fifty in the United States, is considered separately with regard to its methods, its history, and its statistics.

V.—PRODUCTS OF FISHERIES.

Under this head were to be studied the statistics of the yield of American fisheries, past and present.

VI.—PREPARATION, CARE OF, AND MANUFACTURE OF FISHERY PRODUCTS.

Here were to be considered the methods and the various devices for utilizing fish after they are caught, with statistics of capital and men

employed, etc.: (A) Preservation of Live Fish; (B) Refrigeration; (C) Sun-drying; (D) Smoke-drying; (E) Pickling; (F) Hermetically Canning; (G) Fur Dressing; (H) Whalebone Preparation; (I) Isinglass Manufacture; (K) Ambergris Manufacture; (L) Fish Guano Manufacture; (M) Oil Rendering, etc.

VII.—ECONOMY OF THE FISHERIES.

Here were to be studied (A) Financial Organization and Methods; (B) Insurance; (C) Labor and Capital; (D) Markets and Market Prices; (E) Lines of Traffic; (F) Exports, Imports, and Duties.

The fishery industry is of such great importance, and is undergoing such constant changes, that a visit of a few days or weeks to any locality, even by the most competent experts, has invariably proved unsatisfactory. We have therefore been able to collect only the most important facts, selected with special reference to the needs of the report in contemplation, leaving many subjects of interest untouched.

The field-work and the correspondence in connection with it were carried on by the following-named special agents, and approximately between the dates below mentioned:

I. Coast of Maine, east of Portland: Mr. R. E. Earll and Capt. J. W. Collins, August 1 to October 31, 1879; July 29 to October 20, 1880; January 1, 1881 to January 1, 1883.

II. Portland to Plymouth (except Cape Ann) and eastern side of Buzzard's Bay: Mr. W. A. Wilcox, September 2, 1879, to March 1, 1881.

III. Cape Ann: Mr. A. Howard Clark, September 1, 1879 to November 1, 1880; July, August, and September, 1883.

IV. Cape Cod: Mr. F. W. True, July 1 to October 1, 1879; September 1 to October 31, 1880; Mr. Vinal N. Edwards, October 1, 1880, to July 31, 1882.

V. Provincetown: Capt. N. E. Atwood, August 1, 1879, to August 1, 1880.

VI. Rhode Island and Connecticut, west to the Connecticut River: Mr. Ludwig Kumlien, August 16 to October 16, 1880.

VII. Long Island and north shore of Long Island Sound and west to Sandy Hook: Mr. Fred Mather, August 1, 1879, to July 1, 1881.

VIII. New York City: Mr. Barnet Phillips, January 1, 1880, to July 1, 1881.

IX. Coast of New Jersey: Mr. R. E. Earll, December, 1880.

X. Philadelphia: Mr. Chas. W. Smiley and Mr. W. V. Cox, November, 1880.

XI. Coast of Delaware: Capt. J. W. Collins, December, 1880.

XII. Baltimore and the Oyster Industry of Maryland: Mr. R. H. Edmonds, October 1, 1879, to October 1, 1880.

XIII. Atlantic coast of Southern States: Mr. R. E. Earll, January 1 to July 25, 1880.

XIV. Mexican Gulf coast: Mr. Silas Stearns, August, 1879, to July, 1880.

XV. Coast of California, Oregon, and Washington: Prof. D. S. Jordan and Mr. C. H. Gilbert, January, 1880, to January, 1881.

XVI. Puget Sound: Mr. James G. Swan, January, 1880, to January, 1881.

XVII. Alaska Fisheries: Dr. T. H. Bean, June to October, 1880.

XVIII. Great Lakes Fishery: Mr. Ludwig Kumlien, August, 1879, to August, 1880.

XIX. River Fisheries of Maine: Mr. C. G. Atkins, January 1, 1880, to July 3, 1882.

XX. The Shad and Alewife Fisheries: Col. Marshall McDonald, October, 1879, to January 1, 1883.

XXI. Oyster Fisheries: Mr. Ernest Ingersoll, October 1, 1879, to July 1, 1881. (?)

XXII. Lobster and Crab Fisheries: Mr. Richard Rathbun, January 1, 1880, to January 1, 1882.

XXIII. Turtle and Terrapin Fisheries: Mr. F. W. True, October 1, 1880, to January 1, 1882.

XXIV. The Seal, Sea-Elephant, and Whale Fisheries: Mr. A. Howard Clark, November 1, 1880, to February 1, 1881.

In addition to the field assistants already mentioned, a staff of office assistants was employed in carrying on correspondence, searching past records, and preparing the report for publication. Mr. Chas. W. Smiley, Mr. James Temple. Brown, and Mr. G. S. Hobbs were connected with the work from its start, and from a later date Mr. J. E. Rockwell, Mr. C. W. Scudder, Mr. R. I. Geare, Mr. George P. Merrill, and others were thus employed. A number of clerks have also been detailed for this work by the Superintendent of the Census, at one time as many as twenty.

A large part of the clerical force was under the direction of Mr. Chas. W. Smiley, who had in special charge the distribution of circulars and the compilation of their results, and the compilation of summary tables from the records of the Treasury Department.

The expense of the field-work from July 1, 1879, to July 1, 1881, was for the most part borne by the Census, together with that of a large amount of compilation office work carried on by clerks detailed from the Census Office in Washington.

The expense of the preparation of the report, final tabulation of statistics of production, and preparation of illustrations, has been mainly at the cost of the Fish Commission. Since February, 1881, Mr. Goode's connection with the Census Office has been in the capacity of a volunteer; his services in the preparation of the reports and in connection with their publication, having been rendered without compensation, in addition to his regular duties as Assistant Director of the National Museum. In the same manner a large share of the most important work upon special parts of the report has been done as volunteer labor by officers of the National Museum and Fish Commission in addition

to their regular duties. A number of employés of the Fish Commission have been detailed from time to time for special work upon this report for periods varying from four months to two years.

The participation of the Census Office and the Commission of Fish and Fisheries has involved the expenditure of probably nearly equal amounts of money, and the division of the results, so far as they are represented in reports ready for the printer, has been arranged to the satisfaction of both. The extent of the material collected has, however, been much greater than was anticipated, and the portion assigned to the Fish Commission being too bulky for publication in the annual reports, application was made to Congress for permission to print as a separate special report an illustrated work in quarto upon "The Food-Fishes and Fisheries of the United States."

This permission was granted in a joint resolution, worded as follows, which passed the Senate July 16, 1882:

"*Resolved by the Senate* (*the House of Representatives concurring*), That the Public Printer be, and is hereby, instructed to print, in quarto form, a report by the United States Commissioner of Fish and Fisheries upon the food-fishes and fisheries of the United States, the engravings to be in relief, and to be contracted for by the Public Printer under the direction of the Joint Committee on Printing, and to receive the approval of the Commissioner before being accepted; the work to be stereotyped, and 10,000 extra copies printed, of which 2,500 shall be for the use of the Senate, 5,000 for the use of the House, and 1,500 for the use of the Commissioner of Fish and Fisheries. There shall also be printed 1,000 extra copies for sale by the Public Printer, under such regulations as the Joint Committee on Printing may prescribe, at a price equal to the additional cost of publication, and 10 per cent. thereon added."

The manuscript for this report is, in the main, ready for the printer, and several hundred drawings for the illustrations are finished. Part I was placed in the hands of the printer in August, 1882, and is now well advanced toward completion. The contents of the report, it is proposed, shall be as follows:

THE FOOD-FISHES AND FISHERY INDUSTRIES OF THE UNITED STATES.

Introduction, including a general review of the fisheries and a statistical summary.

PART I.—The Natural History of Useful Aquatic Animals.
II.—The Fishing Grounds.
III.—The Fishing Towns, containing a geographical review of the Coast, River, and Lake Fisheries.
IV.—The Fishermen.
V.—The Apparatus of the Fisheries, and Fishing Vessels and Boats.
VI.—The Fishery Industries, a discussion of methods and history.
VII.—The Preparation of Fishery Products.
VIII.—Capital and Labor as employed in the Fisheries.
IX.—Fish Culture, Fishery Laws, and Fishery Legislation.
X.—Statistics of Production, Exportation, and Importation. Summary Tables.

PART XI.—The Whale Fishery—a special monograph.
XII.—The Aboriginal Fisheries.
XIII.—A Catalogue of the Useful and Injurious Aquatic Animals and Plants of North America.
XIV.—A List of Books and Papers relating to the Fisheries of the United States.

The report prepared for the Superintendent of the Census, the manuscript of which is now for the most part in his possession, is divided into the following sections:

A REPORT UPON THE STATISTICS OF THE FISHERIES AND FISH TRADE OF THE UNITED STATES.

Introduction—(giving a comprehensive abstract of the matter contained in the quarto report referred to above).
PART I.—A Review of the Fisheries of the Atlantic seaboard, with statistics of production and manufacture.
II.—A Review of the Fisheries of the Pacific Coast, with statistics of production and manufacture.
III.—A Review of the Fisheries of the Great Lakes, with statistics of production and manufacture.
IV.—A Review of the River Fisheries of the United States. (Prepared by C. W. Smiley.)
V.—A Review of the Consumption of Fish by Counties, with an estimate of the extent and value of the inland fisheries. (Prepared by C. W. Smiley.)
VI.—A Review of the Fish Trade of Cities of the United States having a population of more than 10,000 in 1880. (Prepared by C. W. Smiley.)
VII.—Statistics of Importation and Exportation of Fishery Products from 1730 to 1880. (Prepared under the direction of Mr. C. W. Smiley.)
VIII.—List of the Fishing vessels of the United States in 1880, giving tonnage, value, number of crew, name of owner, branch of fishing engaged in, together with other important details.
IX.—Monograph of the Seal Islands of Alaska, by Henry W. Elliott. (Already in type; 171 pages, 4to.)
X.—Monograph of the Oyster Fisheries, by Ernest Ingersoll. (Already in type; 251 pages.)

The above-mentioned parts will furnish an estimated aggregate of 1,030 pages, quarto, exclusive of the matter already in type. The manuscript of Parts I, II, III, IV, VII, IX, and X, has already been delivered. Parts V, VI, and VIII are held for final revision, but are essentially complete.

The material specified in the last paragraph includes all compilations from circulars, and the results of the work performed by clerks detailed from the Census Office, together with much derived from the archives of the Fish Commission.

The first three sections are mainly made up from the material collected by the special agents in the field, and the form is as nearly as possible that in which it was originally collected. Much, however, has been added from the archives of the Commission.

By the plan just detailed the statistical matter gathered by the joint efforts of the two organizations is assigned to the Census, together with a sufficient amount of descriptive and explanatory text to make the statistics fully intelligible, while the descriptive, historical, and natural history papers are taken by the Fish Commission, these being enriched by a sufficient amount of statistical detail to render them as useful as possible for the class of readers and students for whom they are intended.

The statistical results of the investigations have already been published in a preliminary way. A series of special statistical tables appeared in the Bulletins of the Census Office as follows:

Census Bulletin (1) No. 176.

(Preliminary Report upon the Pacific States and Territories); prepared by Mr. G. Brown Goode from returns of Special Agents Jordan, Swan, and Bean. Dated May 24, 1881. 4to, pp. 6 (x 2.).

Census Bulletin (2) No. 261.

Statistics of the Fisheries of the Great Lakes; prepared by Mr. Frederick W. True from notes of Special Agent Kumlien. Dated September 1, 1881. 4to, pp. 8.

Census Bulletin (3) No. 278.

Statistics of the Fisheries of Maine; prepared by Mr. R. E. Earll from his own notes and those of Mr. C. G. Atkins. Dated November 22, 1881. 4to, pp. 47 (+1).

Census Bulletin (4) No. 281.

Statistics of the Fisheries of Virginia; prepared by Col. Marshall McDonald. Dated December 1, 1881. 4to, pp. 8.

Census Bulletin (5) No. 291.

Statistics of the Fisheries of New Hampshire, Rhode Island, and Connecticut; prepared by Mr. A. Howard Clark. Dated April 5, 1882. 4to, pp. 7 (+1).

Census Bulletin (6) No. 295.

Statistics of the Fisheries of Massachusetts; prepared by Mr. A. Howard Clark from returns of Special Agents, Wilcox, Clark, True, Collins, and Atwood. Dated March 1, 1882. 4to, pp. 35 (+ 1).

Census Bulletin (7) No. 297.

Commercial Fisheries of the Middle States; prepared by Mr. R. E. Earll and Col. M. McDonald. Dated June 5, 1882. 4to, pp. 14. (This bulletin includes statistics of No. 4., C. B. No. 281.)

Census Bulletin (8) No. 298.

Commercial Fisheries of the Southern Atlantic States; prepared Mr. R. E. Earll and Col. McDonald. Dated June 5, 1882. 4to, pp. 18.

In all 148 pages, quarto. In addition to these certain special tables have appeared:

(9) Statistical Table.

Table showing by States the persons employed, capital invested, and value of products in the oyster industry.

(10) Statistical Table.

Statistics of the Fisheries of the United States in 1880; prepared by Messrs. Goode and Earll from the reports of the Special Agents. Printed in the Compendium of the Tenth Census, p. 1402. pp. 2. Reprinted in Bulletin of the United States Fish Commission, Vol. III, 1883, pp. 270–'1, in Preliminary Catalogue International Fisheries Exhibition facing p. 5.

(11) Statistical Table.

Table showing by States the quantity of Spanish Mackerel taken in 1880, and the total catch for the United States. By R. Edward Earll. Report United States Fish Commission, Part VIII, 1880, p. 416.

(12) Statistical Summary.

(Statistics of the Davis Strait Halibut Fishery.) By Newton P. Scudder. Report United States Fish Commission, Part VIII, pp. 190–192.

(13) Statistical Summary.

(Statistics of the Sword-fish Fishery.) By G. Brown Goode. Report United States Fish Commission, Part VIII, pp. 361–'7.

(14) Statistical Summaries.

Statistics of the Mackerel Fishery in 1880. By R. Edward Earll. Report United States Fish Commission, Part IX, pp. (124) (127).

Statistics of the Mackerel Canning Industry. By R. Edward Earll. *Ibid.*, p. (131).

Statistics of the Inspection of Mackerel from 1804 to 1880. By A. Howard Clark. *Ibid.*, pp. (162) (213).

Vessels in the Mackerel Fishery in 1880. *Ibid.*, p. 418.

Catch of Mackerel by Americans in Canadian Waters, 1873–'81. *Ibid.*, p. (430).

(15) Statistical Summary.

(Statistics of the use of Fish Guano as a fertilizer.) By Charles W. Smiley. Report United States Fish Commission, Part IX, pp. 673–693.

(16) Statistical Summary.

(A Statistical review of the production and distribution to public waters of young fish by the United States Fish Commission from its organization in 1871 to the close of 1880.) By Charles W. Smiley. Report United States Fish Commission, Part IX, pp. 826–842.

Two special reports have also been published, as follows:

(17) A Monograph of the Seal Islands of Alaska. By Henry W. Elliott. 4to, illustrated. pp. 172. An addition of this report with substitutions on pp. 102–109 was also issued as a Special Bulletin of the Fish Commission, No. 176.

(18) The Oyster Industry. By Ernest Ingersoll. 4to, illustrated. pp. 252.

The general results of the investigations from the statisticians' standpoint may be briefly summarized as follows:

In 1880 the number of persons employed in the fishery industries of the United States was 131,426, of whom 101,684 were fishermen and the remainder shoremen. The fishing fleet consisted of 6,605 vessels (with a tonnage of 208,297.82) and 44,804 boats, and the total amount invested was $37,955,349, distributed as follows: Vessels, $9,357,282; boats, $2,465,393; minor apparatus and outfits, $8,145,261; other capital, including shore property, $17,987,413.

The value of the fisheries of the sea, the great rivers, and the great lakes was placed at $43,046,053, and that of those in minor inland waters at $1,500,000; in all, $44,546,053. These values were estimated upon the basis of the prices of the products received by the producers, and if average wholesale prices had been considered the value would have been much greater. In 1882 the yield of the fisheries was much greater than in 1880, and prices, both "at first hand" and at wholesale, were higher, so that a fair estimate at wholesale market rates would place their value at the present time rather above than below the sum of $100,000,000.

The fisheries of the New England States are the most important. They engage 37,043 men, 2,066 vessels, 14,787 boats, and yield products to the value of $14,270,393. In this district the principal fishing ports in order of importance are: Gloucester, Portland, Boston, Provincetown, and New Bedford, the latter being the center of the whale fishery.

Next to New England in importance are the South Atlantic States, employing 52,418 men, 3,014 vessels (the majority of which are small and engaged in the shore and bay fisheries), 13,331 boats, and returning products to the value of $9,602,737.

Next are the Middle States, employing in the coast fisheries 14,981 men, 1,210 vessels, 8,293 boats, with products to the amount of $8,676,579.

Next are the Pacific States and Territories, with 16,803 men, 56 vessels, 5,547 boats, and products to the amount of $7,484,750. The fisheries of the Great Lakes employ 5,052 men, 62 vessels, and 1,594 boats, with products to the amount of $1,784,050. The Gulf States employ 5,131 men, 197 vessels, and 1,252 boats, yielding products to the value of $545,584.

14.—INVESTIGATION OF THE ALLEGED DESTRUCTION OF THE TILE FISH.

In preceding reports mention has been made of the tile-fish (*Lopholatilus chameleonticeps*), which was discovered by Captain Kirby in May, 1879. It was described by the ichthyologists of the Fish Commission, and subsequently specimens were captured by the steamer Fish Hawk, August 8, 1880, and again in 1881. During March and April, 1882, vast numbers of dead tile-fish were seen floating in the Atlantic Ocean over an area extending for 38° 4′ to 40° 25′ north latitude and between 69° 50′ and 73° 15′ west longitude. Captain Collins has made a report upon this subject, which will be found in the appendix to this volume.

In order to ascertain the extent of this mortality, the schooner Josie Reeves, of New York, was chartered by the Fish Commission from September 18 to September 24, 1882. On the former date, with Capt. J. W. Collins and Mr. Barnet Phillips on board, the Josie Reeves, Captain Redmond in command, left Greenport for the tile-fish grounds. Considerable difficulty and some delay were experienced in getting a supply of menhaden for bait. In the afternoon of the 20th a locality was reached where tile-fish had been found in abundance during the Fish Hawk's second visit of August 23, 1881. This was at 40° 4′ north latitude and 70° 30′ west longitude. The next morning trawls were set in 160 fathoms. Three fish were taken, but none of them were tile-fish. During Thursday, Friday, and a part of Saturday trawls were set in a variety of places—along a range of 50 miles—without securing a specimen of the fish under quest. The unpropitious state of the weather prevented a longer continuance of the search. Captain Collins became satisfied, however, that the tile-fish was not to be found in that region. A full report of the cruise of this vessel has been made by Captain Collins, and has been published in the Fish Commission Bulletin for 1882, Vol. II, pp. 301–310.

After using every possible effort to reach a conclusion, the party returned to Wood's Holl, reporting the entire absence of the fish on the ground where, doubtless, a year before, hundreds might have been taken with the same amount of effort. The search was rewarded, however, by the discovery of a second fish of very excellent quality, belonging to the genus *Setarches*, but closely related to the genus *Sebastes*. Small specimens had been previously taken by the Fish Hawk, but these in question, amounting, as they did, to several pounds in weight, indicated their existence of commercially available size.

15.—THE POLE FLOUNDER.

It will be remembered that in previous reports reference has been made to the discovery, by the United States Fish Commission, in vast numbers, off the eastern coast of New England, of the Pole Flounder—*Glyptocephalus cynoglossus*. This is believed to be more abundant in that re-

gion than any other species of its family; but it can only be taken by the beam trawl, the smallness of its mouth preventing the use of the ordinary baited hook.

During the explorations of the summer from Wood's Holl large quantities of this species were captured in localities very far to the south of the region where first discovered; and specimens were sent to Mr. Blackford, at New York, to be submitted to experts and connoisseurs as to their edible qualities. A unanimous approval was given of the fish as being of remarkable excellence, and as in no way inferior to the English sole in its best condition.

16.—MODELS OF THE FISHING-GROUNDS.

Professor Hilgard, of the United States Coast Survey, several years ago kindly undertook the supervision of the construction by Mr. Lindenkohl of a model to show the fishing banks of the eastern coast of New England, including the Grand Banks of Newfoundland. This constituted one of the most interesting American objects at the Berlin Fishery Exhibition.

Desirous of showing some of these banks on a larger scale, a similar arrangement was made with Professor Hilgard for the construction by Mr. Lindenkohl of a model of the Gulf of Maine for exhibition at the London Fishery Exposition. The Coast Survey itself had prepared by Mr. Lindenkohl a model of the entire eastern coast of the United States and the Gulf of Mexico with the special view of showing the depth of the basin of the Gulf Stream as developed by the more recent researches of the Blake.

It is expected that these several models will be very prominent features of the London Exhibition.

17.—FUNGUS DISEASES OF FISH.

The subject of the fungus disease which attacks fish, especially the fresh water salmonidæ, is one of great importance, in view of the very serious injury that has been done to the British salmon fishery by this agency. An elaborate report on this subject, made to the British Government by Professor Huxley, has been republished by the Commission; but as the conditions in American waters and with American species may be somewhat different, Dr. Farlow has kindly undertaken an investigation of the subject in the interest of the United States Fish Commission. As material becomes procurable it will be forwarded to Dr. Farlow for this purpose.

18.—WORK DONE AT WOOD'S HOLL IN 1882.

In a preceding part of this report will be found an account of the measures taken to establish, at Wood's Holl, a permanent station for prosecuting investigations into the fisheries, and for the propagation of marine fishes.

In spite of the impossibility of commencing work during 1882 in the construction of the permanent station, it was determined to make Wood's Holl again the headquarters of the general work of the Commission, and as a large number of persons were expected to join the party during the summer, it became necessary to make special arrangements for their accommodation. The hotel which constituted the headquarters of the Commission for the year 1881 was closed, and it became necessary for the Commissioner to lease it. Before possession could be taken, however, the building was burned to the ground on the 16th of May, but by the kind assistance of Mr. Joseph S. Fay, of Wood's Holl, the building used in 1881 for the assistants of the Commission was fitted up as headquarters, and a second building obtained for offices. Most of the party were billeted in different rooms throughout the village. A steward was employed in Washington, who carried with him the necessary corps of assistants, and a general mess for the entire party was kept in the headquarters building. This arrangement was found to be quite satisfactory, although involving more or less inconvenience.

I left Washington on the 27th of July, and reached Wood's Holl on the 28th, a special car from Fall River to Wood's Holl having been furnished by President Choate, of the Old Colony Railroad Company, for the accommodation of several invalids.

The Fish Hawk arrived on the 26th of July.

As heretofore the marine invertebrate work was under the direction of Prof. A. E. Verrill, who had as his assistants Messrs. Emerton, Sanderson Smith, Bruner, Linton, Koons, etc. The fishes were cared for for by Peter Parker, jr., and Mr. Miner. A portion of the office staff also accompanied me, consisting of Messrs. H. A. Gill, J. P. Wilson, and Edward Hayes.

The Fish Hawk made several trips to the Tile-fish ground, for the special purpose of determining whether the destruction of the tile-fish referred to in another part of the report was as extensive as reported. The results will be found under the head of the Tile-fish.

In view of the the fact that many species of deep-sea fishes collected by the Fish Hawk had previously been taken under the supervision of Mr. Agassiz, by the Coast Survey steamer Blake, an arrangement was concluded with that gentleman by which all the species of this character, collected by the Fish Hawk, would be worked up by Mr. G. Brown Goode and Dr. Tarleton H. Bean conjointly, and a provisional report published, first in the Bulletin of the Museum of Comparative Zoölogy, followed by an illustrated paper in the Memoir. This has, accordingly, been done, and a valuable addition to science has been the result.

19.—INVESTIGATION OF THE FISHES OF THE ADIRONDACK REGION.

In connection with the proposed exploration by Dr. C. Hart Merriam, of the natural history of the Adirondack region, an arrangement was

made with him to secure a series of the fishes, for the purposes of the Commission, and the necessary alcohol being provided, a very interesting collection was made by him. He will himself prepare a report on the subject for publication.

C.—PROPAGATION AND INCREASE IN SUPPLY OF FOOD-FISHES.

20.—BY PROTECTIVE MEASURES ENFORCED WHEN NECESSARY BY LAW.

As explained in previous reports, the duty first assigned by Congress to the United States Fish Commission was that of investigating the condition of the fisheries of the rivers, lakes, and seas of the United States, as compared with that in former years, and of suggesting measures for protecting and increasing the supply. It was not until the second year, or 1872, that the subject of the propagation of the food-fishes was added. This division of the work, however, has increased year by year, until now it represents by far the largest portion of the expenditure.

Preventing willful and wasteful destruction of adults or young.—There are a number of methods by which the increase in the supply of fishes in a given region can be brought about. The simplest of these is the avoidance of their capture at improper times and of their willful destruction. All desirable fishes should be spared as much as possible during the spawning season, as it is at such times that they are exposed to special danger. A fish that has safely escaped to the period when the eggs and milt are ripe for the purpose of propagation should be permitted to perform that function without interference. Of course, after the eggs are deposited with the assurance of their development and the growth of the young, the parent fish cease to be of any serious moment, especially as one act of spawning is all that many kinds ever perform. When taken, however, before spawning, the expectancies of future yield are necessarily nullified. Legislation in this direction has been directed more particularly to the protection of the salmon and the trout; the close time usually beginning a month or two before the ripening of the eggs.

In the case of shad the prohibition of capture after some date in June has been found very serviceable.

Exclusion of poisonous or injurious waste from the waters.—Another method of securing an increase consists in taking the necessary measures to prevent the introduction of foul waste, such as will either kill or injure the adult fish or young, or interfere with the development of the eggs. Under this head may be mentioned poisonous matters from factories, such as paper and dyeing establishments, and gas and ammonia works; also the refuse of saw-mills, the saw dust getting into the gills of the parent fish, or else covering up the spawning beds, so that these will not discharge their proper functions.

Removal of obstructions to the movements of fish and of injurious engines of capture.—A third method of favoring the natural increase of fish consists in removing the natural or artificial obstructions to the ascent of the fish from the lower to the higher waters of a stream, or their descent in the opposite direction. Spawning fish, notably the shad, the fresh-water herring, and the salmon, enter the mouths of rivers from the sea at the appointed time and find their spawning ground at various points on the river, the herring low down, the shad in the medium districts, and the salmon more toward the head. The interposition of artificial dams, unsurmountable by the fish, has been a great and perhaps the chief factor in diminishing the supply in this class of fish, as with the erection of a dam, especially near the mouth of a stream, the spawning fish ascending are arrested, and are either turned back from their course or else fail to find a suitable place or opportunity to deposit fertilized eggs. For the first two or three years there will be a continually lessening of the run of the fish. At the end of this time, however, or when all the fish born in that stream have been caught or destroyed, the run ceases, and after that, even though the obstruction be removed, the river will remain practically barren of fish until restocked by human agencies.

Again, even in many cases where the adult fish succeed by their own efforts, or by the use of fishways, in getting to the headwaters of the rivers, the progeny is destroyed in enormous quantity by the so-called fish-baskets or weirs, which take the young by myriads. The most potent agents in this respect are the eel traps or dams, which consist for the most part of two converging lines of stone walls, with the apex pointing downwards, and ending in a so-called fish basket. Here eels, upon their descent to the salt water, are taken in great quantities, and with them the young of shad, salmon, bass, etc.

It may safely be stated that nothing has done more to diminish the number of adult fish, and prevent their increase in our waters, than this engine of destruction. Nothing short of absolute removal and prohibition of such "fish-baskets" will answer the purpose; although, of course, such prohibition will interfere with the take of the much desired eels. Still the interests of an entire community should be considered paramount to those of a few farmers living near the streams in question. The other obstructions, whether natural or artificial, constitute a factor in some instances greater than the fish-baskets, and sometimes less. There are many streams, such as the Susquehanna and the Delaware, where the parent or spawning fish can, under favorable circumstances, make the ascent and deposit their eggs—the young fry, however, to be caught by the fish-baskets. In other cases, where the passage upward is barred by the obstruction in question, the fish-baskets are of less importance, as being confined in their action to a smaller number of species. The young eels coming up from the ocean in the spring, can make

their way up an obstruction unsurmountable by the shad, or even by the salmon; so that there are very few waters in the eastern portion of the United States where descending eels cannot be captured.

All these methods of protection of fish and of enabling them to carry out their mission, whether adults or young, are usually the subjects of legislation; and in some countries very stringent laws are in existence, and enforced by the constant vigilance of wardens.

The general principles just presented have relation for the most part to the protection of the fish, and to the enabling them to perform their reproductive functions undisturbed at the critical time.

Erection of fish-ways.—It is not my purpose at present to go into the more detailed discussion of the various methods of protection of fish, or into the question of suitable laws to establish such protection; but I confine myself to the subject of "fish-ways," which has always occupied a good part of the attention of the Commission.

In the report for 1872–'73, pp. 591–616, I have published an elaborate account of the different methods of constructing fish-ways for facilitating the ascent of fish over obstructions in the rivers, including all that were known, or in common use, at the time, and some which were devised by assistants of the Commission.

Numerous forms of fish-ways have been more or less successful, especially in connection with the movements of the salmon. This fish is very vigorous, and able, by leaping, to surmount vertical falls of quite a number of feet in altitude, the number varying with the strength of the fish. No height less than 6 or 8 feet is believed to be insuperable to the salmon; but other fishes, especially the shad, are less powerful, and for these fish-ways are needed in many cases where they are not necessary for salmon.

It is but fair to state that, so far, the ordinary methods of fish-ways have not been successful in facilitating the upward run of the shad, and in spite of a great deal of ingenuity and much expenditure of money and experiment, the problem cannot yet be considered as entirely solved.

The device of Col. Marshall McDonald, one of the principal assistants of the United States Fish Commission, holds out very great promise of success in this respect, and it is proposed to test this apparatus at the Great Falls of the Potomac River, Congress having made an appropriation for the purpose.

There is no locality where a successful fish-way would do more in the way of increasing the supply of shad than on the Potomac River, as the stream below the Great Falls now represents a most productive locality for shad, and the waters above the Falls would furnish the most favorable opportunities imaginable for the spawning of eggs and development of the young. The general character of the device selected will be found under the head of the Great Falls Fish-way.

21.—BY ARTIFICIAL AGENCIES.

The other division of the subject relates to the actual stocking of the waters artificially, either by transfer from one locality to another or by the introduction of eggs artificially impregnated, or of young fish, the results of hatching these eggs after being impregnated. It is a very serious question which of these two great divisions, protection or propagation, is the more important. In some cases preference would be given to the one, and in some to the other. Either method alone is largely insufficient; it is the combination of the two that gives us the best results.

Transplanting of fish from one region or locality to another.—By this term I refer to fish that have been born in the waters by the natural process and transferred to distant points. Sometimes this is done accidentally, as when fish-ponds are broken down by floods, and the fish are carried into larger waters. More generally, however, this term represents a special feature of the service of many of the western State Fish Commissions.

The high floods of the spring and summer frequently carry into the adjacent fields or prairies great numbers of fish, which, as the waters recede, are left, either in these localities or in bayous belonging to the main stream, to perish. Many millions of fish are annually destroyed in this way. The State commissions, however, have aided greatly in preventing the loss, by carefully gathering up the young fry as well as the adults, thus concentrated, and returning them to the main river.

Artificial propagation.—The method of intentional transplantation just referred to is very important in its way, and should be carried out as largely as possible. It is, however, to the artificial propagation of the fish, whether of the lakes, the rivers, or the ocean, that we may look with the greatest assurance of a profitable result. There is no doubt that many serious disappointments have been experienced as the result of work actually initiated in this direction, and the hopes not only of a rapid recovery from depletion, but also of an increase in the supply, have in many cases been entirely blasted; so that at the present time it may safely be said there is much less enthusiasm as to the results than before.

Failures have resulted in a large degree from the limited scale on which the work has been carried out. If the expectancy of destruction in a given locality be estimated as representing one million young fish, and any number *less* than one million be introduced therein, it is easy to understand that there will be no result.

In the earlier days of the Fish Commission large quantities of eggs and young were unprocurable, and it was only by gradual processes that the spawning fish were multiplied sufficiently to answer the purpose in question. This, however, has been accomplished in the case of the shad and some other species, so that where six or eight years ago

one messenger could carry all the young procurable in a given time, a car holding ten or twenty times that amount is at present easily filled.

Too much, however, must not be expected from artificial propagation, as it has to contend, not only with the depletion by excessive fishing, but also with changes of physical condition, such as temperature, etc., that require increased efforts to meet and overcome, and possibly, in some instances, the substitution of other species better able to resist the changes in question. In some cases the preventable difficulties mentioned above successfully antagonize all the efforts made.

22.—NEED OF A FISH-WAY AT THE GREAT FALLS OF THE POTOMAC.

The importance of maintaining at their maximum of production the valuable fisheries of the Potomac can hardly be over-estimated, in view of the extent to which they furnish food for home consumption and for transportation, and also of their agency in reducing the expense of living to the poorer portion of the population. The fish involved in this consideration are the shad, herring, rock, white perch, and black bass, together with other fish coarser in quality and lower in price.

Old records dating back to colonial times bear testimony to an abundance of production, which, read in the light of present experience, seems little short of marvelous, although after all credible when we consider the favorable conditions for natural production which were then afforded.

The broad estuary of the Potomac River, extending for a distance of more than 100 miles, from Point Lookout to the Great Falls, offered through its whole length numerous flats and bars where the shad could spawn, rarely molested by the intrusion or device of man. Its reedy shores and extensive tracts of marsh land, covered with aquatic grasses, furnished everywhere a nidus and a nursery for the countless million of eggs of the glut herring (*Pomolobus aestivalis*).

Into the numerous creeks tributary to the main river, which have their origin in the swamps of the interior, the branch herring (*Pomolobus vernalis*) entered to find at their sources a suitable resting place for its eggs and a safe habitat and temporary abiding place for its young.

How the hand of man has changed all this will be evident from the following considerations: Access to the sources of the smaller tributaries of the Potomac, which drain the tide-water region, has been almost universally barred by mill-dams placed at the head of tide. The conversion of the woodland along their banks into arable fields has rendered turbid their once clear waters, and with every rain a muddy torrent is sent down, loaded with fine sediment, which settles upon and stifles every embryo of shad or herring which may have found a resting place in the reaches below tide level. In addition, fykes and stake nets, weirs and pound or trap nets bar access of mature fish to these streams almost as effectually as the dams prevent their ascent.

In the main river the favorable natural conditions which formerly ex-

isted have disappeared before the encroachments of man. Cities have grown up along its banks which each year discharge into its waters an increasing volume of sewage, gas tar, and other deleterious substances to pollute the water and render it unfit for healthy development of the eggs that may be deposited. Large seines occupy every reach where the fish congregate to spawn, or stretch their broad arms across the channel to intercept the schools of shad and herring in their upward migrations. From every headland pound nets stretch their meshes a thousand feet or more from shore to guide the unwary fish into the traps, which are set on the edge of, and often in, the navigable channel.

Hundreds of gillers, with nets a hundred fathoms long, stretched across the channel, drift up and down, on ebb and flood, unceasingly, and with their fine-spun nets, almost invisible, obstruct ascent as effectually as if strong dams of stone or timber barred the passage.

Such being the condition of things on the Potomac at the present time, the conclusion was readily reached that if the spawning grounds of the shad and herring could be enlarged by taking in the long reaches of river that lie above the Great Falls a great gain could be secured. This, however, could only be done by providing convenient passage for them over or around this obstruction.

Accordingly, when the necessity of an increased water supply for the city of Washington was brought before Congress by the Commissioners of the District of Columbia, I addressed a letter to Maj. W. J. Twining, then Engineer Commissioner of the District, calling his attention to the propriety of including, in any proposition for the completion of the dam at the Great Falls, the construction of a suitable fish-way to admit the ascent of shad, salmon, striped bass, herring, sturgeon, etc., to the upper waters of the Potomac River. Subsequently, in response to the invitation of the Committee on the District of Columbia in the House of Representatives, I addressed them the following communication:

UNITED STATES COMMISSION FISH AND FISHERIES,
Washington, D. C., June 1, 1882.

Hon. HENRY S. NEAL,
Chairman Committee on District of Columbia,
House of Representatives:

DEAR SIR: In response to the inquiries made by your committee through the Hon. Mr. Garrison, I would submit the following:

In 1871, in compliance with an act of Congress, I was designated by the President to conduct an inquiry into the causes operating to diminish the supply of food-fishes on the sea-coast and the lakes of the United States. The investigations had made but little progress before I became convinced that the obstructions in our rivers, whilst not the only cause, were one of the main factors in determining the reduction in the numbers both of the anadromous fishes, such as the salmon, shad, and herring, and the salt-water species, the food of which consists largely of the anadromous species referred to. In the case of the salmon, shad, and herring (alewives) the effect was direct and immediate. The obstructions in some rivers have entirely excluded these fishes from their

spawning grounds, rendering the waters barren in a few years; in others the reduction in the spawning areas has entailed a corresponding diminution in the productive capacity of the river, and caused important and remunerative fisheries to become comparatively valueless.

In the case of the salt-water predaceous species, the effect of obstructions in the rivers, whilst indirect, has been not the less potent in effecting a reduction of their numbers by diminishing their food supply.

In my annual reports to Congress I have had frequent occasion to revert to the disastrous effects of dams in our rivers in determining a reduction in the supply of our more important food fishes, and to urge the erection of fish-ways as a most important and indispensable adjunct to the restoration of our fisheries by artificial propagation, a work so wisely inaugurated and so beneficently sustained by liberal appropriations.

Usually the work of construction of fish-ways may appropriately be left to the States themselves, or to the coercion of State laws brought to bear upon the owners of dams. In those cases, however, where the General Government has created or maintains obstructions in our streams it seems eminently proper and in essential harmony with the work of artificial propagation, inaugurated and sustained by the Government, that suitable provision should be made to provide sufficient passage-way for fish over the obstructions.

My views in regard to the expediency and propriety of the General Government undertaking the work at the Great Falls have already been expressed in a letter to the Commissioners of the District, a copy of which is inclosed for the information of your honorable committee.

I can only add to the argument presented in that letter that the water supply requisite for the fish-way will be necessarily under the control of the District government, and must be subordinated to the necessities of the water supply of the District. This renders it necessary that the fishway, when built, should be operated subject to the entire control of the authorities of the District government.

I may state in conclusion that the opening of the upper waters of the Potomac and its tributaries to the ascent of fish cannot have other than a most beneficial effect upon the production of the river. That such a result may be attained there is no reason to doubt. The difficulties that may present themselves are mainly those of construction, and are entirely within the resources of the engineer to overcome.

I have the honor to be, very respectfully,

S. F. BAIRD,
Commissioner.

UNITED STATES COMMISSION OF FISH AND FISHERIES,
Washington, D. C., March 24, 1882.

DEAR SIR: I would respectfully suggest the propriety of including in any proposition for the completion of the dam at the Great Falls the construction of a suitable fish-way to admit the ascent of shad, salmon, striped bass, herring, sturgeon, etc., to the upper waters of the Potomac River. Prior to the building of the original dam, it was possible for many of these varieties of fish to reach their spawning grounds; but of late years this has been rendered impossible, and, consequently, the supply has most materially decreased. Many of the fish of the Potomac must have access to the upper waters of the river for the propagation of their kind, suitable spawning grounds not occurring below the dam.

Inasmuch as the injury above alluded to was brought about by an act

of the United States, it seems eminently proper that the same agency should remedy the difficulty, especially as the locality where such fish-way alone can be built is the property of the United States. The legislatures of Maryland, Virginia, and West Virginia are highly in favor of the improvement in question, and I see no impropriety in the granting of this proposition.

At the proper time I shall be happy to furnish a plan of construction upon the most feasible and efficient scale. The expense of this additional work will make but a small item in the total. It is important that for such construction some such proviso as that below should be added to the bill as it now stands.

Yours, very respectfully,

S. F. BAIRD,
Commissioner.

Maj. W. J. TWINING,
Engineer Commissioner, D. C.

Provided, That a suitable construction shall be built to admit of the upward passage, at all seasons of the year and at all stages of the water, of shad, salmon, herring, striped bass, sturgeon, etc., the same to be erected in accordance with the plans to be furnished by the United States Commission of Fish and Fisheries.

The committee accepted these recommendations, and reported to the House the original bill amended, so as to provide for suitable fish-ways at the Great Falls of the Potomac.

The bill, which became a law July 12, 1882, appropriated $50,000 for the construction of the fish-ways, and directed that the same should be erected according to plans and specifications to be furnished by the United States Commissioner of Fish and Fisheries.

Immediately after the appropriation became available, I detailed Col. M. McDonald, chief of the division of distribution in the United States Fish Commission, to take charge of the preparation of the plans and specifications, and to proceed at once to arrange for the necessary surveys. Colonel McDonald reported to Maj. G. E. Lydecker, Engineer Commissioner, in October, and was authorized by him to organize a field party and complete the necessary surveys, the expenses being certified to him for payment.

Mr. F. S. Eastman was designated as chief of the field party, and, in company with Colonel McDonald, made a reconnaissance of the ground. This developed four practicable sites for the erection of the fish-way. The one immediately at the Great Falls on the Maryland bank of the river was definitely determined on for reasons given by Colonel McDonald in his report.

The necessary minute survey of the site selected was deferred from time to time in consequence of the serious indisposition of Mr. Eastman; and the fatal termination of his illness making it necessary to secure the services of another engineer, Professor Hilgard, Superintendent of the United States Coast and Geodetic Survey, kindly detailed Mr. Eugene Ellicott, one of his staff of field assistants for the purpose. Unavoidable delays threw the field work into the most inclement season of winter, and necessitated the maintenance of the party in the field for a longer time,

and adding proportionately to the cost of survey. This work is now completed, and the map of the site proposed submitted. The preparation of the plans and specifications will proceed as rapidly as is consistent with the careful study of all the conditions involved, and an observance of the requirements necessary to insure ultimate success.

23.—DISTRIBUTION OF FISH AND EGGS.

The general principle of distribution of fish and eggs, referred to in the report of 1881, has continued during 1882, excepting that the transfer of fish in baggage cars of express trains, under charge of single messengers, has been much reduced in extent.

As long as the number of eggs and young fish was restricted, this was the most convenient and economical mode of performing the service. Now, however, with increasing supplies of shad, salmon, carp, etc., it is found that car-load shipments are much more economical.

These have been made partly on the transportation car of the Commission and partly in express cars engaged for the purpose. As the fish are always carried on passenger trains, it is, of course, understood that the cars must be suitable for such service.

An appropriation having been made by Congress for a second transportation car, the experience gained in fitting up No. 1 was made use of in the plan of No. 2. This plan was made by Mr. F. S. Eastman, who also superintended the construction. A contract was made with the Baltimore and Ohio Railroad Company for the work, and the car was delivered to the Commission, entirely finished, on September 13, 1882, the total cost amounting to $7,334.21.

Great difficulty has been experienced from the break of gauge on the Southern roads; all the Northern roads having a gauge of 4 feet 8½ inches, and the Southern system having adopted a 5-foot gauge. This made it necessary to secure a pair of trucks of the broad-gauge patterns, and to keep them at some point in the South, either at Wilmington, Danville, or other stations, where the change of the car from the one system to the other could be accomplished.

24.—SPECIES OF FISH CULTIVATED AND DISTRIBUTED IN 1882.

Within the last few years considerable changes in the names of the fishes most generally treated by the Fish Commission have resulted from the more extended research into the synonymy of the subject; these relating more particularly to the western *Salmonidæ;* and, in order to define with precision what the species are with which the Commission has to do, I first present the list, and then propose to take up each species separately and to give an account of the work bestowed upon it and the general results for the year. The complete synonymy will be found in an article by Dr. Bean in the appendix.

1. The sole (*Solea vulgaris*).
2. The turbot (*Rhombus maximus*).
3. The cod (*Gadus morrhua*).

4. The mackerel (*Scomber scombrus*).
5. The Spanish mackerel (*Scomberomorus maculatus*).
6. The striped bass (*Roccus lineatus*).
7. The white perch (*Roccus americanus*).
8. The black bass (*Micropterus dolomieu*).
9. The banded porgy (*Chætodipterus faber*).
10. The common whitefish (*Coregonus clupeiformis*).
11. The maræne (*Coregonus lavaretus*).
12. The brook trout (*Salvelinus fontinalis*).
13. The lake trout (*Salvelinus namaycush*).
14. The sälbling (*Salvelinus salvelinus*).
15. The rainbow trout (*Salmo irideus*).
16. The Atlantic or Penobscot salmon (*Salmo salar*).
17. The land-locked or Schoodic salmon (*Salmo salar* subsp. *sebago*).
18. The river trout (*Salmo fario*).
19. The Quinnat salmon (*Oncorhynchus chouicha*).
20. The shad (*Clupea sapidissima*).
21. The branch herring (*Clupea vernalis*).
22. The glut herring (*Clupea æstivalis*).
23. The sea herring (*Clupea harengus*).
24. The carp (*Cyprinus carpio*).
25. The gold-fish (*Carassius auratus*).
26. The golden ide (*Leuciscus idus*).
27 The tench (*Tinca vulgaris*).

a. **Whitefish** (*Coregonus clupeiformis*).

The Northville and Alpena stations.—Mr. Frank N. Clark, in charge of the Northville and Alpena (Mich.) stations, in the appendix to this volume, makes an interesting report of the labor carried on by him during 1882. The work performed in his department shows double the results obtained heretofore in a single year. The new station at Alpena was fitted up expressly for the hatching of whitefish, and about 32,000,000 of these fish were planted from that station in the Great Lakes. At the Northville station about 30,000,000 eggs of whitefish were received. Of this number 12,000,000 eggs were shipped to various points in the country, and 16,000,000 were hatched and deposited in the Great Lakes. There were handled at this station also 277,000 lake trout, 473,000 brook trout, 7,000 rainbow trout, 1,400 "German" trout, and 20,000 land-locked salmon; and 1,500 carp were distributed, in lots of 20, to applicants in the Northwestern States. The station has been increased in efficiency by the addition of two new ponds for breeding purposes. The Alpena hatchery, which has just been completed, is believed to be a model establishment. It contains, besides a hatching room, an office and dormitory and a storage room. The hatchery proper, which has a capacity for treating 100,000,000 eggs, is equipped especially for whitefish. The arrangements for supplying pure water and cutting it off at will

are especially satisfactory. The eggs of the whitefish were obtained this year in the usual manner; that is, from the ripe fish found in the nets of the fishermen. This plan is satisfactory only when all the concurring circumstances are favorable. Bad weather may interfere so as to destroy any possible chance of success. Mr. Clark now states that experiments have demonstrated the feasibility of holding the immature spawners in confinement until every egg has been secured, thus making it possible to save the entire crop of eggs not deposited by the fish themselves. The greater part of the eggs at the Detroit hatchery during the season were obtained in this way; and those eggs which were taken from fish brought from Lake Erie in casks, and held in tanks in the hatchery till they had matured, were found to be the very best procured at Northville. The improved condition of the eggs is due to the fact that by the new method much greater care is possible, and the hurry and confusion of pound-net operations is avoided. Mr. Clark hopes next year to follow this method to the exclusion of every other.

The eggs of the lake trout were obtained from the fish taken in gill-nets, and then shipped to Northville. The weather at the time was warm and many of the eggs arrived in Northville in poor condition. By the experience gained this year, and the improved facilities, it is hoped that a much better showing, both as to quantity and quality, will be made next season. The total number of lake-trout eggs taken was 277,000. Besides the usual number of transmissions to persons in the United States, a number of these eggs were sent to the Deutscher Fischerei-Verein of Germany and the Société d'Acclimatation of France. Mr. Clark also hatched out a number of trout eggs received from Germany. There were 5,000 in all, and they reached Northville on the 26th of March. The greater number of them were too far advanced to hatch out satisfactorily. A considerable portion, however, reached maturity, and are now doing very well indeed. They are quite as large as our own trout of the same age. Mr. Clark reports a failure with regard to the propagation of the rainbow trout—the first serious failure that the Northville establishment has made. Only 45,000 eggs of this species were obtained, of which but 15 per cent. could be fertilized. The number of fish hatched was 6,400. He is somewhat at a loss to discover what was the cause of the difficulty, but is inclined to attribute it to the abnormal character of the fluid surrounding the eggs. He suggests as another possible explanation that the parent fish were overfed, and that the inflow to their pond gave them a current too slow and feeble, the result being that they became too inactive. He proposes hereafter to try the experiment of reducing their food allowance to the minimum and placing them in a good current of water in one of the new ponds. Such treatment would seem to be in accordance with their natural habits. Twenty thousand eggs of land-locked salmon, from Grand Lake Stream, Maine, arrived at this station March 12, and were hatched out satisfactorily. The loss was trifling. They were distrib-

uted, when hatched, to lakes in Michigan. Mr. Clark remarks that land-locked salmon have done well in Michigan lakes, quite a number of adult specimens having been taken during the last year. The brook-trout work, too, was entirely satisfactory. Four hundred and seventy-three thousand eggs of this species were obtained, of which number 357,000 were shipped away, and 50,000 hatched. The whitefish fry were shipped from Northville by Fish Commission car, and from Alpena by car and boat. In this work the car was run over 7,000 miles. As a rule, the railroad companies made no charge for hauling the cars of the Commission. Two million fish were usually taken on a trip.

An interesting experiment is being made at the Northville hatchery in growing whitefish in confinement with the aid of artificial feeding. Mr. Clark placed in confinement 1,200 of the fry hatched March 12. On the 1st of September 276 were alive in good condition, and some of them were as much as six inches in length. This is the most successful experiment of the kind ever made, and opens up great possibilities in the future. Like young trout, they were fed exclusively on chopped liver. They grow very rapidly. Forty-seven million young whitefish were deposited in the following lakes: Lake Ontario, Lake Erie, Lake Huron, Lake Superior, and Lake Michigan.

Mr. Clark calls the attention of the Commission to the importance of making arrangements for penning up whitefish, so that the immature eggs may have a chance to ripen, and the whole work of removal and transportation be facilitated. He finds the whitefish particularly suited for this work, fully as much, if not more so, than the salmon or trout. He reports that Mr. Oren Chase, assistant superintendent of the Michigan State establishment at Detroit, was the first to adopt this method, finding it of the utmost possible benefit.

Mr. Douglass, at Sandusky, in behalf of the Fish Commission of Ohio, was successful in the same operation, taking several millions of eggs from penned fish.

The matter had not been brought to Mr. Clark's attention sufficiently early in the year to make the necessary arrangements for practical work, but his experiments in that direction were satisfactory, and he proposes in 1883 to carry out the process on a large scale, seeing no reason why the yield of eggs may not be brought up to hundreds of millions if necessary. It is to be understood, of course, that the treatment of the fish in this way does not injure it for market purposes.

For many years past, some of the establishments on the Detroit River have been in the habit of seining for the whitefish and placing them alive, when caught, in pools, thence to be taken out as the demands of the market might require. Considerable use was made of the opportunity of taking eggs from the ripe fish before they were put into the pool, but no artificial processes were subsequently applied to them. It is understood, however, that a great amount of natural spawning followed, with a very decided advantage to the fisheries of the river.

There has been a considerable amount of criticism on the part of State commissioners as to Mr. Clark's practice of hatching out white-fish "prematurely," as they call it, and, in their opinion, placing them in the lake when the water is too cold for them. A careful examination of the subject, however, does not substantiate the assertions, and the reasonings themselves are faulty. There is no reason to believe that the eggs are hatched out earlier in the Northville hatchery than they are spontaneously in the lakes, and the investigations by Mr. Forbes prove conclusively that, although the microscopic food for the young fish is not so much concentrated in cold weather as it is when warmer, there is yet an ample supply.

Among the special features of interest in the island of Mount Desert is a lake of deep, cold water of considerable extent, which is thought to be suitable for the growth of white fish.

At the request of Mr. Montgomery Sears, of Boston, who is a summer resident of Mount Desert Island, in the vicinity of this lake, I gave instructions to Mr. Frank N. Clark to set aside 1,000,000 eggs of the white fish in the Northville hatchery for the lake in question, and as there were no facilities at the lake for hatching out the eggs, I ordered the lot to be sent to the salmon station at Bucksport, there to be brought forward to a sufficient size for planting.

The eggs arrived at the Bucksport station on February 26, packed in one case, and were found to be in good condition. The temperature of the moss was below 35 degrees. A small percentage, however, hatched out and died; so that there was some smell about the package. The eggs were then carefully washed and put into water at a temperature of 33 degrees. A few hatched out within twenty-four hours.

Mr. Buck, the assistant to Mr. Atkins, who had charge of these eggs, thought it best to keep them at the hatchery, if possible, until the ice should be out of Eagle Lake, and the steamers running to Mount Desert. He therefore continued the use of the coldest water (below 34 degrees) until April 19. At that time about half of the eggs were hatched, and Mr. Buck took one twenty-gallon can filled with young fry to Mount Desert, for the purpose of making arrangements for the delivery of the entire number.

He found that the ice had thawed around the edges of the lake, and had no difficulty in finding a suitable place for introducing the fish.

The temperature of the water used in developing the eggs on April 26 had reached 37 degrees, by which time all the eggs were hatched out.

Mr. Buck on that day reached the lake at 9 o'clock p. m.; and in his opinion successfully planted 700,000 of the young fry.

The scarcity of suitable cans made it necessary also to use four casks which had received two coats of shellac on the inside. All the fish, however, transported in the casks died on the way.

Mr. Buck states that the fry taken down on the 19th were liberated upon the north side of the lake, about one-fourth of a mile westward

from the outlet. Those liberated on the 26th were taken up the eastern shore in boats as far as the ice permitted, and scattered along shore as much as practicable; most of them from one-half to three-fourths of a mile from the outlet, all upon rocky bottom.

The results of this experiment will be looked for with much interest; and by 1885 the increase, if any, should be appreciable.

b. The Atlantic or Penobscot Salmon (*Salmo salar*).

The Bucksport (Me.) Station.—The report of Mr. Charles G. Atkins, the assistant in charge of the Maine hatching stations, shows a very satisfactory condition of affairs there. As usual the United States Commission carried on this work in connection with the fish commissions of Maine, Connecticut, New Hampshire, and Massachusetts. The first Penobscot salmon eggs were taken October 28. The total number of eggs taken was 2,090,000. These were obtained from 250 females, showing an average of 8,360 eggs per fish. Ninety-eight per cent. of these eggs were successfully impregnated, and 95.7 per cent. were shipped; in round numbers 2,000,000. The share of these belonging to the United States was 1,208,000. The mortality among the spawners kept in the inclosure was considerably less than in 1881. This is attributed to the smaller size of the Penobscot variety this year. Penobscot salmon eggs are now shipped in the same way that they have been for years at the Maine stations, except that layers of chopped hay are used instead of moss. Moss is difficult to obtain, and hay is found to be a very satisfactory substitute. In all cases, however, wet bog moss is still the material in which the eggs are first embedded.

All the packages reached their destination in safety, and the hatching was so successful that 1,716,617 healthy young salmon were turned out in public waters.

Mr. Atkins furnishes an interesting chapter in regard to marked salmon. In the autumn of 1880, 103 females and 81 male salmon were marked with the usual platinum tags. The fish were, at the close of the spawning season, let loose. In the spring of 1881, 12 were recovered. This number was less than had been hoped for, though it was probably as large as could be expected.

The data obtained in this way affords a substantial corroboration of the conclusions drawn from previous experience. Four females, in two years, increased 40 per cent. in weight and 14 per cent. in length. These experiments, in Mr. Atkins's opinion, warrant us in saying that salmon visit the Penobscot River for the purpose of spawning but once in two years, and that they visit it for no other purpose.

The number of fish purchased and held by Mr. Atkins for spawning purposes was 470; of eggs, as stated above, 2,000,000 were secured.

The Roslyn (N. Y.) Station.—Desirous of hatching salmon eggs intended for New York waters in some central station from which the young fry could more readily be distributed, I placed the matter in the

hands of Mr. Fred. Mather, and Mr. E. G. Blackford, fish commissioner of New York.

Mr. Thomas Clapham kindly offered the use of his establishment at Roslyn, on the north shore of Long Island, in Queens County, New York, a station on the Locust Valley or Glen Cove branch of the Long Island Railroad, distant 23 miles from New York, where trout ponds had been constructed some years before, together with a building intended as a hatchery.

The only special work necessary for this station was the construction of troughs. Unfortunately, the eggs were received before the troughs were properly tarred and dried, and the success was not as great as would otherwise have been the case.

With 344,500 eggs received, 170,000 fish were planted in tributaries of the Hudson River; 45,000 in Salmon River, a tributary of Lake Ontario, and 10,000 escaped in Clapham's Stream.

The salmon hatching of the ensuing autumn and winter was prosecuted at Cold Spring Harbor, on Long Island, a new station of the New York State fish commission.

c. **Schoodic or Land-locked Salmon** (*Salmo salar* subs. *sebago*).

Grand Lake Stream Station.—Extensive improvements have been made at Grand Lake Stream Station, on the Schoodic Lakes, in the way of new buildings for hatching and other purposes. It is thought that with the increased accommodations any procurable stock of eggs can be well cared for. The Schoodic salmon work commenced about the middle of September and ended November 4. The total number of male fish obtained was 600; females, 1,004; constituting the finest fish as to size and condition ever taken at that station. The males averaged 3.1 pounds in weight; the females, before spawning, 3.2 pounds. Measurements show that the average length of both sexes was eight-tenths of an inch more than in 1880, and the fish this year were also heavier. The number of defective eggs yielded by the fish was smaller than ever before. It was found that about 91 per cent. of the eggs were successfully impregnated—about the ordinary rate. Nine hundred and forty-five out of the 1,014 females taken yielded spawn which weighed 727 pounds, and the number of eggs was 1,681,000. The yield of eggs per female fish averaged 1,779, the highest average yet recorded at the station.

The total number of eggs of the Schoodic salmon for distribution, after deducting all losses, was 1,428,330 eggs. Of this number 374,330 were reserved for Grand Lake, and the remainder, 1,108,000, shipped to the several subscribing commissions. The share of the United States Commission was 478,000 eggs. The transportation of the eggs, which was performed in the usual manner, was entirely successful in results. The fish as a rule were hatched out successfully, and were placed in rivers and ponds in the Eastern, Middle, Western, and one or two Southern States.

The Roslyn (N. Y.) Station.—Reference has already been made to this station in charge of Mr. Fred. Mather, under the head of "Atlantic Salmon." It was also used for bringing forward a number of eggs of land-locked salmon, hatched out for distribution in New York.

From 10,000 eggs received on February 18, 1882, 5,000 fish were planted in Skaneateles Lake on May 2, and 5,000 placed in the waters of the South Side Club of Long Island.

d. **The Lake Trout** (*Salvelinus namaycush*).

The Northville Station.—Not much was done during 1882, in connection with this species, by the United States Fish Commission. A few hundreds of thousands of their eggs were taken by Mr. Clark of the Northville Station, and developed for distribution, as indicated in the general table.

The largest amount of this work appears to have been done by the New York State commission.

The lake trout is not considered a very palatable variety, and there is consequently very little demand for it. Whenever it is called for, to stock waters unsupplied with this fish, the eggs can be readily obtained and supplied.

e. **The Quinnat or California Salmon** (*Oncorhynchus chouicha*).

The McCloud River Station.—Mr. Livingston Stone, in charge of the salmon-breeding station on the McCloud River, began active work September 3, and it was continued till September 25, at which time he had over 4,000,000 eggs in the hatching house. Mr. Stone had been instructed to take only about this number and then to give them to the California Fish Commission to be hatched out and placed in the Sacramento. This action of the United States was thoroughly appreciated by the California Commission. One of the commissioners stated officially that the annual salmon catch of 5,000,000 pounds depended entirely on the work of the United States Commission. Although breeding fish at this station this year were scarce, their weight exceeded that of the breeders of any previous season. The average weight of the females after spawning was about 14 pounds. One fish before spawning had the enormous weight of 27 pounds. Mr. Stone, is his report, bears cheerful testimony to the help of the Indians in the vicinity of the station. Their services were almost invaluable to him in the prosecution of his work.

Mr. Stone made some interesting experiments in impregnating eggs of the salmon. He allowed the eggs to remain in the pan for periods of different lengths before the milt was put on, the eggs being taken in a dry vessel and no water used until after impregnation. The result of these experiments indicates that when the milt is eighteen hours old it is impotent; second, that impregnation does not occur if the eggs are washed immediately after milt is added; third, that there is a slight chance of impregnating successfully eggs taken from dead fish; fourth,

that milt is more efficacious the sooner it is applied to the eggs. The Canada process was found to be a very successful method of impregnation. In this process the eggs of one fish at a time are taken in a dry pan, and as soon as impregnated each pan of eggs is poured into a bucket of water. Another process was to take the eggs and milt together in a dry bucket as rapidly as possible. This method was found to be inferior to the Canada process.

f. **The California, Rainbow or Mountain Trout.** (*Salmo irideus*).

Although the work of the Fish Commission has been mainly limited to the anadromous species, such as the salmon, shad, fresh-water herring, &c., it was found expedient to bestow some attention to the more local forms, especially the California mountain trout, which, it is thought, will answer an excellent purpose in supplying streams which formerly abounded in the Eastern brook trout, but which, by reason of the clearing of the land, with the consequent reduction in the volume and the change in the other characteristics of the water, no longer answer that purpose.

The selection of the California trout is based on the fact that they are known to exist comfortably in waters several degrees warmer than the temperature suited to our common brook trout.

The McCloud River Station.—Mr. Stone's report on the trout-breeding station on the McCloud River shows that 337,500 eggs of trout were distributed to various parts of the United States.

The taking of eggs extended from the 5th of January to the 5th of May. The spawning season on the whole was quite successful. Great care is necessary in transporting these eggs, as, besides, the 3,000 miles of journey by rail, they must be carried a considerable distance on horseback and by stage. Reports from the consignees of these eggs (principally fish commissioners of the different States) say that the eggs arrived in excellent condition, the proportion of bad eggs being very small. Mr. Stone lost very few fish by death. Even during the spawning season very few died. The trout recuperate very rapidly after spawning. The ponds now contain about 2,000 trout, which weigh from 2 to 10 pounds apiece. Mr. Stone concludes, after a thorough examination of the subject, that there is only one variety of black-spotted trout in the United States ponds on the McCloud River, or that if there are two varieties they shade into each other by imperceptible degrees.

The various scattering lots of trout eggs ripening in too small quantity to be worth shipping to the East were presented to the California State Fish Commission. These were more than made up by a number obtained from the Lenni Fish Propagating Company in exchange for eggs of the California salmon.

The Northville (Mich.) Station.—A number of years ago Mr. Clarke, in charge of this station, established primarily for the hatching of the whitefish, when on a visit to the salmon and trout ponds of the

United States Fish Commission on the McCloud River, brought back a number of these fish, and took proper care of them until they became mature. He then made the necessary arrangement to take their eggs, and for several years this station, next to that on the McCloud, has furnished the principal supply. A considerable portion of the California stock of eggs is sent to Northville and hatched out for distribution, enough being retained to maintain the breed. In 1882, 45,000 eggs were received February 2, and 40,000 February 20. Of this last lot only 393 were found to be dead.

The eggs obtained from the Northville establishment entered into the general distribution made by the Commission.

The Wytheville (Va.) Station.—The better to hatch out eggs of the mountain trout to supply the Southern Alleghanies with this desirable species it was found to be necessary to establish a station specially for the purpose of this enterprise; one, of course, where an ample supply of cold spring water could be readily obtained, and yet not too remote from the city of Washington to be under constant supervision. This station was found at Wytheville, Va., where several years ago the State Commission had established, and successfully worked, a station for the propagation of trout.

Satisfactory arrangements were made with the Virginia State Commission, through Colonel McDonald, to rent the station in question, at the expense of the United States Fish Commission, and maintain it in the interests of the same.

In order to make the necessary improvements to carry out the work on the scale contemplated, the services of Mr. C. E. Junkin, of the Coast Survey, were secured in 1881 for the purpose of making a topographical map of the station.

The actual work of the Commission at the station was inaugurated in February, 1882, when 25,000 eggs of the *Salmo irideus* were received from the ponds at Baird, Cal. They were taken charge of by Mr. E. H. Walke, who has for several years been associated with the United States Fish Commission and the North Carolina State Fish Commission, in the hatching of shad; and the station remained under his direction until Mr. Seagle, its regular keeper, had acquired sufficient familiarity with the treatment of the trout to be able to care for them himself.

Twelve thousand five hundred healthy fry were obtained from this crop of eggs, a portion of which will be held for distribution to adjacent localities when of sufficient size and the remainder kept for breeders.

By planting young fish in streams in the immediate vicinity, and gradually extending the range, it is hoped that, in due time, the whole of the Southern Alleghany region can be supplied, and an extension secured over a vast area of country. It is proposed to enlarge the station by the construction of new ponds, which will, of course, admit of carrying on the work on a much greater scale.

g. **The Brook Trout** (*Salvelinus fontinalis*).

Northville Station.—In view of the fact that the brook trout has constituted one of the principal objects of consideration by the Fish Commissioners and fish culturists in the Northern States, it has not, as explained in previous reports, received much attention from the United States Fish Commission. A small supply of breeders is, however, maintained by Mr. Clarke at the Northville (Mich.) hatchery, and the product has been distributed to a few special localities—for the most part sent to Europe, in exchange for other species. The disposition in question will be found recorded in the table of distribution in Mr. Clarke's report. There were 473,000 eggs obtained, 357,000 eggs shipped, and 50,000 fry hatched. Those shipped to Europe invariably arrived in good condition.

h. **The Shad** (*Clupea sapidissima*).

Quantico Station.—Three stations for the propagation of shad were operated on the Potomac River during the season of 1882.

The Fish Hawk, under command of Captain Tanner, was stationed at Quantico and collected eggs from that section of the river lying south of Indian Head. In addition to the work of shad propagation, many millions of eggs of the river herring were hatched and planted in local waters. Of the product 2,000,000 fry were sent by car No. 2, and planted in the Colorado River, at Austin, Tex., the experiment being made with the expectation that this species could be acclimated in these waters, and from its wonderful fecundity become an important addition to the resources of the river. Should these anticipations be realized, it is proposed to plant this species largely in all the tributaries of the Gulf of Mexico.

In this connection it may be mentioned that the first Potomac shad of the season was said to have been taken on the 21st of February; this was at White Point, Va., nearly seventy miles below Washington.

A summary of the work done is as follows:

	Number.
Eggs taken and impregnated	2,407,000
Shad furnished for distribution	800,000
Herring furnished for distribution	2,000,000
Shad deposited in local waters	1,755,000
Herring deposited in local waters	7,883,000

For fuller details in regard to the work of the station, reference is made to the report of Captain Tanner.

Navy-yard Station.—This station was in charge of Lieut. W. M. Wood, commanding the Lookout, Master W. C. Babcock and Master A. C. Baker being in immediate charge of the hatchery. Eggs for the supply of this station were collected from Moxley's Point and the gillers in that section of the river around Fort Washington; the Lookout being employed to collect and transfer the eggs to the station. During the season 21,820,000 shad eggs were collected, which yielded 17,935,000 fry. Of these 3,050,000 were deposited in local waters, 14,444,000 turned

over to Central Station for distribution, and 441,000 sent directly to deposit in the Potomac at Little Falls.

Central Station.—To this station was allotted that section of the river extending from Chapman's to Ferry Landing. The methods adopted for the collection of the eggs, as well as the apparatus in use for hatching at the station during this season, are novel, and mark a substantial advance toward that concentration of work and economy in production which is necessary in order that the results obtained may compensate for the expenditures made in artificial propagation. What is now known as the dry method of transportation was employed in the collection and transfer of the eggs to Washington. Instead of being sent in vessels of water by messenger, after being impregnated they are transferred to shallow trays covered with damp cloth, and forwarded by the ordinary channels of communication on the river, reaching the station at periods from six to thirty-six hours after impregnation. On arrival at the station they are immediately transferred to the automatic hatching jars, by which the separation of the dead eggs is completely effected without the use of scalp nets or other appliances for the purpose, involving mechanical labor and constant attention.

The methods of transportation employed and the apparatus for hatching in use at the station during the season have given complete satisfaction. The number of eggs received at the station during the season was 6,706,000. The number of fry hatched out, 5,393,000.

The distribution of shad to new waters was made largely through Central Station, the total number of fry distributed during the season being 20,637,000. This total includes the plants made in the Potomac River, but does not include those made in the Susquehanna River from the Havre de Grace Station.

Of this total 800,000 were drawn from the Havre de Grace Station on the Susquehanna, and 19,837,000 from the Potomac River stations; the Navy Yard Station contributing 14,444,000, and Central Station 5,393,000.

The most notable feature of this distribution was the planting of large numbers of fish in single localities, instead of distributing, as heretofore, in smaller lots to a number of localities in the same stream. The extreme distance of the distribution was the Colorado River in Texas, and the Smoky and Republican Rivers in Kansas. The total distance travelled by the cars in this distribution was 12,192 miles; 9,730 miles being made by car No. 1, and 2,462 by car No. 2. The total number of shad fry produced during the season of 1882 at all the stations, and including those deposited directly in the Potomac and Susquehanna rivers was 30,283,000.

Battery Station.—In 1879 the shad and herring eggs collected from the fish taken on the Chesapeake flats and procured from the large seines hauled in the neighborhood of Havre de Grace, Md., were hatched

on floating barges, anchored in Spesutie Narrows, a narrow channel separating Spesutie Island from the mainland.

To enable the steam launches used in this work to ply between the fisheries and this central hatching station at all stages of the tide, it was necessary that a channel should be dredged across the bar which had formed at the northern mouth of the narrows. By special instructions from the President, or Secretary of War, Colonel Craighill, in charge of the engineer work of the district embracing the Chesapeake Bay, had a channel dredged which greatly facilitated the work during the season.

Having secured for a term of years the fishing advantages of Battery Island (which is situated in the center of the bay, about 3½ miles directly south from Havre de Grace), as being a location much more central to the fisheries from which we received the spawn, Colonel Craighill was advised of our plans, and in compliance with a resolution of the Senate, made a survey of the surroundings and an estimate of the cost of deepening the channel and constructing the piers and a breakwater necessary for the conduct of our work; but it was not until the following year (1880) that an appropriation was made. The work was commenced in July of that year.

A channel was dredged to the island, securing a draft of 7 feet, and a pool of the same depth, formed by crib-work filled with earth and stone, was formed for the protection of the hatching barges and small boats of the Commission, and also for the storing of the live fish which might be taken before the eggs were thoroughly developed in the ovaries. In this pool the "unripe" fish will be retained, and the eggs taken from time to time as they mature. The material dredged from the channel and the pool was thrown behind the crib-work and raised considerably the level of the remaining portion of the island.

Additional appropriations for strengthening and extending the piers were provided for in the bills for river and harbor improvement in the following years (1881 and 1882), sufficient, it is hoped, for the completion of these improvements, and the work has thus far been prosecuted in a most satisfactory manner.

As the fishery on this island was one of the most successful and remunerative of the large fisheries of the Upper Chesapeake, it is confidently anticipated that we will have ample material in the way of parent fish, and that the production of young shad will be greatly increased and the operations carried on much more compactly than heretofore.

In the spring of 1881 two small cottages, one of five rooms and the other containing two rooms, and an ice-house, constructed on the Ridgway principle, were erected at the station, and the cottages occupied as quarters for the corps during the fishing season.

It was not, however, practicable until the spring of the present year (1882), to erect a suitable hatching house, the hatching operations hav-

ing been conducted during the previous year on the hatching barges, as heretofore, with the exception that they were moored in the pool above referred to instead of occupying the location in Spesutie Narrows.

During the present year a spacious two-story hatching house, about 20 by 60 feet, has been erected. A section of 20 feet of this contains the engine, boiler, and water-tank. The remainder of the first floor of the building is devoted to the hatching apparatus, and as its capacity is many millions of eggs it is hardly probable that the floating apparatus will be needed at this station hereafter.

The second story of this building furnishes comfortable accommodations for from sixteen to twenty men, and has been provided with steam heating apparatus, the steam being furnished from the same boiler which does the pumping and seine hauling.

During the summer and fall considerable work has been done toward the construction of an apron for landing the seine. This important work, however, had to be intermitted on account of the ice, but sufficient has been done to insure its completion in the early spring—in time to be available for the fishing during the coming season.

The northern pier has been considerably extended and strengthened during the present year by the force under the direction of Colonel Craighill. This work is important as this pier, as extended, forms, with that already constructed, an outer harbor protected from the ice as well as from the westerly and northerly winds, while the island makes a lee from all easterly winds and the original or southern pier gives thorough protection from those from the south, making a safe mooring for the small boats of the Commission outside of the pool. The pool can hereafter be devoted exclusively to the reception and care of the fish taken in the seine.

North East River (Md.,) Station.—After the shad work in the Potomac was over the Fish Hawk was moved to Havre de Grace and continued its work in hatching shad. The first eggs were taken May 23 and the work continued until June 12, a total of 2,551,000 eggs having been secured from 191 shad. There were hatched 1,765,000 fish, of which 1,555,000 were returned to the North East River and 210,000 furnished for shipment. About 25,000 eggs which remained on hand June 12 were turned over to Battery Station.

In previous reports accounts have been given of the work prosecuted by the United States Fish Commission at Avoca, N. C., the fishing station of Doctor Capehart, near the mouth of the Chowan River. This station was not occupied during the season of 1882, but the work there was prosecuted by the North Carolina Commission, under the direction of Mr. S. G. Worth. The total number of fish hatched was 2,260,000, which were planted in the principal rivers of the State.

The following statement of distribution of shad from 1872 to 1881 may be of interest:

Released where hatched	93,041,450
Hatched and planted elsewhere	71,334,300
Lost in transit or experiments	4,515,100
Sent part way to Germany	500,000
Total to 1882	169,390,850

The accompanying table gives a summary of the distribution of shad by States. Add the aggregate of this (28,716,000) to the preceding table, and we have as the total of distribution for the years up to and including 1882, nearly 200,000,000 to date.

Distribution of shad from April 26, 1882, *to June* 17, 1882, *by the United States Fish Commission.*

States.	No. of lots.	Streams stocked.	Number of fish.
Alabama	3	Alabama, Conecuh, Escambia	850,000
Arkansas	2	Black, Washita	432,000
Delaware	1	Nanticoke	891,000
District of Columbia.	1	Eastern Branch	3,050,000
Georgia	10	Chattahoochee, Oconee, Yellow, Coosa, Etowah, Oostanala, Withlacooche, Flint.	2,831,000
Illinois	1	Kaskaskia	145,000
Indiana	1	Wabash	145,000
Iowa	1	Mississippi	958,000
Kansas	5	Smoky Hill, Saline, Solomon, Republican, Big Blue	222,000
Kentucky	5	Kentucky, Cumberland, Salt, Green, Barren	1,900,000
Maine	2	Sebastacoock, Mattawamkeag	475,000
Maryland	19	Potomac, Susquehanna, North East	7,769,000
New York	3	East, Hudson	983,000
Ohio	4	Sandusky, Muskingum, Scioto, Hockhocking	1,595,000
South Carolina	2	Broad	497,000
Tennessee	1	Tennessee	400,000
Texas	3	Colorado, Big Cypress, Trinity	1,518,000
Virginia	18	Quantico, Rappahannock, Appomattox, Shenandoah, Rivanna.	3,605,000
West Virginia	2	Ohio, Potomac	450,000
Total	84		28,716,000

i. **The Potomac Herring** (*Clupea vernalis*).

Quantico Station.—A large number of herring as well as of shad eggs were taken by the Fish Hawk while anchored at Quantico. The opportunity was utilized to make some experiments in hatching these eggs. Between April 12 and May 9 there were taken 677 ripe male herring and 644 females. These furnished 66,206,000 embryonized eggs. Although most of these were killed by the cold water, 7,883,000 were successfully hatched and for the most part returned to the river. Two millions were, however, deposited in the Colorado River, at Austin, Tex., on the 2d of May, in hopes of establishing the species in the Gulf of Mexico.

Record of herring-hatching operations conducted by the United States Fish Commission steamer Fish Hawk, Lieut. Z. L. Tanner, United States Navy, commanding, at Quantico Creek, from April 12 *to May* 9, 1882.

Date.	Herring taken.		Eggs obtained.	Eggs lost.	Returned to local waters.	Used for experiments and sent to armory.
	Males.	Females.				
1882.						
April 12	3	2	40,000	500	....	....
12	3	3	100,000	500	....	....
13	3	4	250,000	1,500	....	....
13	2	3	50,000	4,500	....	....
14	29	24	2,200,000	2,200,000	....	....
15	24	22	1,330,000	1,330,000	....	....
16	7	6	600,000	600,000	....	....
17	52	55	6,800,000	6,800,000	....	....
18	7	8	1,400,000	1,400,000	....	....
18	12	10	1,000,000	....	....	1,000,000
19	5	5	2,100,000	....	....	2,100,000
20	2	2	450,000	450,000	433,000	....
21	29	27	3,400,000	3,400,000	....	....
23	15	15	1,600,000	1,600,000	....	....
24	23	19	3,350,000	3,350,000	....	....
25	63	64	6,600,000	6,600,000	....	....
26	46	47	4,500,000	1,800,000	....	....
27	48	45	3,600,000	2,300,000	....	....
28	93	82	7,780,000	7,780,000	....	....
29	25	23	2,250,000	1,650,000	....	....
30	15	15	1,200,000	1,200,000	....	....
30	15	15	1,300,000	350,000	....	....
May 1	61	57	5,796,000	3,896,000	....	....
3	31	33	2,900,000	900,000	1,300,000	....
4	6	4	500,000	500,000	....	....
5	3	4	360,000	360,000	1,450,000	....
6	....	....	....	....	2,000,000	....
7	14	15	1,400,000	1,400,000	2,700,000	....
8	29	25	2,350,000	2,350,000	....	....
9	12	10	1,000,000	1,000,000	....	2,000,000
	677	644	66,206,000	53,223,000	7,883,000	5,100,000

j. The Carp (*Cyprinus carpio*).

The Washington Stations.—The service of the United States carp ponds has been faithfully superintended during the year by Mr. R. Hessel, under whose charge they were originally laid out, and who has had direction of them ever since. In addition to rendering this station a serviceable one, considerable attention has been paid to landscape effects by the proper arrangement of islands and ponds, and also by the introduction of plants, which, while having a beneficial relationship to the fish, add to the attractions of the place. The ponds are all very beautiful in their general effect, and in time will doubtless be pre-eminent in this regard.

The water-lily group, especially those belonging to the genera *Nymphœa* and *Nelumbium*, have been particularly cultivated, so that there is quite a large number of rare species represented.

The advice of Mr. J. F. Olmstead, the landscape engineer, was obtained in regard to certain ponds which could be used by skaters. For the purpose of aiding in the means of amusement to the citizens of Washington, one of the reserve ponds is usually prepared for the use of skaters by removing the fish and keeping the water up to the proper level. Some years there is not ice enough to allow this amusement,

but the surface of the pond was sufficiently covered to allow skating on the 3d of January, and for some considerable time subsequently.

The ponds were a second time frozen over on the 9th of December and became again the resort of a large number of people.

As a return for favors extended to the Deutsche Fischerei-Verein, Herr von Behr forwarded a number of blue carp, a variety believed to be of particular interest, and which has not been heretofore cultivated by the Commission. These arrived on January 4, and on examination of them by Mr. Hessel nineteen were found to be pure blood, and were placed in the ponds. Four hybrids were destroyed.

It may be stated in this connection that for several years a night heron and a bald eagle have been kept alive in cages and fed with refuse and hybrid fish, thus adding to the interest of the station. These same fish were also fed to the terrapin and turtles, kept in their special ponds.

The drawing of the ponds for the purpose of removing the carp is always an occasion of much interest, large numbers of persons usually resorting to the ponds to witness it. At the drawing on the 1st of April the President and many members of Congress were present.

Distribution of carp.—In this distribution it was necessary to provide for the supply of nearly 10,000 applicants, located in all sections of the United States. To make it by messenger shipments, as in previous years, would have involved an expense considerably exceeding the entire amount appropriated for the propagation and distribution of this fish. It was determined, therefore, as far as practicable, to make the distribution by means of car and express shipments. For this purpose centers of distribution convenient to one or more States were established, to which the fish were sent in bulk, and thence distributed to applicants by express.

The cost of the movement of the fish from Washington to the centers of distribution thus established was paid by the United States Fish Commission, the small express charges thence to destination being paid by applicant. This method was adopted in order to place all applicants, however distant they might be from Washington, upon the same footing so far as expense was concerned.

In anticipation of the opening of the season a new car with refrigerating compartments had been constructed according to plans furnished by Mr. Frank S. Eastman, engineer officer of the Commission. The old car was also remodeled in its interior arrangements so as to conform essentially in construction to the new car.

The season opened with a car shipment to Boston, in which arrangements were made for the supply of all applicants in the New England States, New York, and Northern New Jersey. From this time to the close of the season the cars were in continual movement, the theater of distribution being transferred further and further to the south as the winter advanced, the last movement of car No. 1 being to San Fran-

cisco, Cal., with carp for the supply of Texas, Arizona, New Mexico, California, Nevada, Oregon, and Washington Territory.

The following summary of distribution will be of interest:

Carp were sent into two hundred and ninety-eight of the three hundred and one* Congressional districts, and into 1,478 counties. There were 260,000 carp distributed, in lots of 20, to 9,872 applicants, residing at an average distance of 916 miles from Washington, the extreme points supplied being Southern California, Oregon, and Washington Territory, which were reached by special messenger from San Francisco. The total mileage traversed, counting all as single shipments from Washington to destination, was 9,045,000 miles. The distance traversed by the cars in making this distribution was 34,502 miles, of which car No. 1 traveled 20,601 and car No. 2, 13,901 miles. Details of this work will be found in the report of Col. M. McDonald, chief of division of distribution.

k. **The Codfish** (*Gadus morrhua*).

The Fulton Market (*New York*) *Station.*—The experiment of hatching cod at Wood's Holl, Mass., having been seriously interfered with by the extreme cold of the winter of 1881, it was deemed advisable to make Fulton Market, New York, an experimental station. To this point considerable numbers of cod are brought alive by the fishing smacks, which capture them in the neighborhood of Block Island.

Mr. E. G. Blackford, one of the commissioners of fisheries of the State of New York, and a large fish dealer of Fulton Market, having every opportunity of observing the condition of the fish arriving at this market, and informing himself of the occurrence of spawning fish, was requested to notify us when ripe fish appeared, and arrangements were made to send on expert fish culturists for the purpose of establishing an experimental station.

As this was impracticable of accomplishment in the immediate vicinity, on account of the foulness, and its lack of proper salinity, in the water around the docks of New York, it was necessary to collect the eggs at Fulton Market and transfer them to some other point. It was therefore decided to try first the experiment of bringing the eggs to Washington, and using sea water brought from Chesapeake Bay, and also artificially prepared water from the sea salt, in their development at the Central Station; second, if this did not prove feasible, another experiment was deemed worthy of test, viz, after collecting the eggs in New York, to transfer them to the hatching steamer Fish Hawk, which would be stationed for the purpose in the lower part of Chesapeake Bay, where the dangers from encountering ice would be comparatively small.

If either of these experiments should result favorably, the multiplica-

* Those not supplied were the second district of Rhode Island and the sixth and seventh of New Jersey, from which no applications were entered.

tion of cod and their transfer to limits further south than their present habitats, could be done at comparatively small cost, and to an almost unlimited extent.

Preliminary arrangements were also made looking to the transfer of the live parent cod direct from the fishing banks where they were taken, to the mouth of the Chesapeake Bay near Norfolk, where they could be kept in cars until the eggs became mature in the ovaries. This had been attempted the previous season at Wood's Holl, but the forming of "anchor" ice in the Little Harbor (which is fatal to the fish) had interrupted the work. This last experiment was postponed, as it was attended with considerably more cost than the hatching operations contemplated in Washington and on the Fish Hawk.

On the 14th of February, among the cod captured in the neighborhood of Block Island, were found several with the ovaries sufficiently mature and about four millions of eggs were taken on that date, but a comparatively small number of these proved to be properly impregnated, as ripe male fish were exceedingly scarce.

The first lot of eggs, received February 16, at Central Station, was a total loss. This was attributed to the apparatus in which they were transmitted from New York. Several lots in hermetically sealed vessels at a very low degree of temperature arrived in a very much better condition. The development was carried forward eleven days, at which time the fish were plainly visible in the eggs. Although lost at this stage it was considered quite encouraging that eggs which had been transported so far and subjected to such varying conditions attained this degree of maturity.

About this time Prof. John A. Ryder was sent to New York to watch the development of the eggs, with instructions to reserve samples from the different lots for development on the spot, and ascertain, if possible, the cause of the mortality, and to learn with accuracy the stage at which the eggs died.

On the 25th of February the Fish Hawk was ordered to proceed from Washington to the mouth of the Potomac River, with instructions to examine certain oyster beds of Chesapeake Bay in that neighborhood, and set her nets in order to ascertain whether there was any movement of fish in the bay. Her tanks having been supplied with salt water, advantage was taken of this opportunity for testing the second experiment. She sailed on the above-mentioned date with a large number of cod eggs immediately after their arrival from New York. These died within twenty-four hours of their transfer to the hatching apparatus. The full details of this experiment will be found in the extract given below from Captain Tanner's report.*

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*On the 25th of February there were received on board 1,000,000 cod eggs from the United States Fish Commission, which were placed in spawning pans with artificial sea water for transportation to Chesapeake Bay, when they were to be placed in the

By this time the season had so far advanced that there was little prospect of obtaining material for further experiment, so the force was recalled from New York, and the cod work discontinued for the season.

The experiments made by the Commission clearly show that special preparations must be made for collecting and keeping the parent codfish for a considerable time and in suitable water. It is hoped and believed that the arrangement proposed for the Wood's Holl Station will answer every purpose, and that in a few years the work will be a complete success.

Much interest has been excited both in Europe and America by the experiment of the Commission with codfish, and the commissioners of several foreign governments have asked permission to witness them. A similar favor was asked by Mr. Harvey, of Saint John, Newfoundland. At the proper time it will, of course, be a pleasure to welcome any one to the station desirous of seeing it operated.

m. **The Striped Bass** (*Roccus lineatus*).

It was not possible to accomplish anything during the year in reference to the artificial propagation of the striped bass, no localities presenting themselves of sufficient promise to warrant the establishment of hatching stations. The success, however, of the experiment made a few years ago of the transportation by Mr. Livingston Stone, of the United States Fish Commission, of striped bass to California, has induced the commissioners of that State to renew their efforts, and Mr. Woodbury was sent East to obtain a fresh supply of the young fry.

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cones for hatching, using water from the bay. About 75 per cent. of the eggs appeared to be alive when they were brought on board.

At 12.50 p. m. on the date above mentioned, we left the navy-yard and steamed down the Potomac River; at 10.45 p. m. anchored in Cornfield Harbor.

The cod eggs were distributed among three cones and one glass aquarium, the water of the bay and river being used; they sank to the bottom, showing that the specific gravity was much less than that of sea water. They were then treated as shad eggs, the feed water being admitted at the base, and discharged through the gauge at the top of the cone in the usual manner. The aquarium was covered with one thickness of white bunting, which prevented oscillation by the motion of the vessel, and allowed the water to escape freely. A quarter-inch glass tube was introduced as a feed-pipe, and the discharge took place through the bunting cover. The temperature of the water was 40° F. at the surface, and 41° F. in the cones.

On the 26th, about 60 per cent. of the eggs seemed to be alive, although little or no development had taken place since the day before. They sank promptly, and the ordinary water feed for shad hatching would not keep them at the surface.

When the eggs were received on board they were 0.06 of an inch in diameter, germinal disk, $\frac{1}{125}$ of an inch, the live eggs seeming to be healthy. During this day, the germinal disk appeared to have contracted, and the proportion of dead eggs rapidly increased.

On the morning of the 27th, there were but few cod eggs alive, and they were in an abnormal condition, the germinal disk distorted, shrunk, and shriveled.

At 9.10 p. m. no good cod eggs were to be found in the cones.

On the 1st of March all the dead cod eggs were thrown overboard and the tank, cones, &c., cleaned and properly cared for.

Guided by information from Mr. Blackford, Mr. Woodbury obtained, at Red Bank, N. J., on July 13, yearlings from 4 to 5 inches in length. No fish of the year's spawning were obtained. Several hundreds of these were successfully transported to California and placed in waters there by Mr. Woodbury.

n. **The Black Bass** (*Micropterus*).

In accordance with the policy of the Fish Commission, no special efforts have been made looking toward the introduction of the black bass into new waters of the United States. All that has been done in this respect has been performed either by State commissioners or by individuals. Without pretending to decide as to the expediency of such introduction, the United States Fish Commission has surrendered this department as stated. Its intervention, however, has been invoked by various parties abroad, and on the 2d of July arrangements were made to supply Count von Dem Borne, of Germany, with a quantity of these fish. On September 30, Mr. William T. Silk reached New York to obtain bass for Lord Exeter, of England, from whom he brought letters. Mr. Silk was placed in communication with Mr. E. G. Blackford, who assisted him in securing a supply from Greenwood Lake. These were carried to England with but little loss, and divided between several parties who had made preparations to take care of them.

n. **The White Perch** (*Morone americanas*).

The Quantico Station.—During the stay of the Fish Hawk at Quantico there were taken in the shad seines 34 male perch and 39 female in a ripe condition. These yielded 1,630,000 embryonized eggs. From these eggs there were hatched 180,000 fry, which were deposited in Quantico Creek.

Record of perch-hatching operations conducted by the United States Fish Commission steamer Fish Hawk, Lieut. Z. L. Tanner, United States Navy, commanding, at Quantico Creek, from April 12 *to May* 5, 1882.

Date.	Perch taken.		Eggs obtained.	Eggs lost.	Returned to local waters.	Used in experiments.
	Male.	Female.				
1882.						
Apr. 12	1	3	40, 000	10, 000	....	....
15	2	2	50, 000	50, 000	....	....
17	2	2	100, 000	100, 000	....	....
18	4	3	100, 000	....	....	100, 000
19	1	1	40, 000	....	....	40, 000
20	4	3	150, 000	150, 000	30, 000	....
20	2	1	100, 000	100, 000	....	....
21	1	2	50, 000	50, 000	....	....
22	1	1	50, 000	50, 000	....	....
26	1	2	25, 000	25, 000	....	....
27	2	6	400, 000	400, 000	....	....
28	3	2	75, 000	75, 000	....	....
29	2	2	50, 000	50, 000	....	....
30	6	6	300, 000	150, 000	....	....
May 5	2	3	100, 000	100, 000	150, 000	....
	34	39	1, 630, 000	1, 310, 000	180, 000	140, 000

o. **The Oyster** (*Ostrea virginica*).

Saint Jerome Station.—The work of experimenting with the artificial incubation of the eggs of *Ostrea virginica* was carried on at the Saint Jerome Creek Station during the summer of 1882, under the direction of Mr. John A. Ryder. These researches have been discussed at some length in a paper by Mr. Ryder, entitled "An account of the experiments in Oyster Culture, and observations relating thereto, second series" in the present report (pages 763–778), to which the reader is referred for further details.

The following brief summary of the results obtained may, however, not be out of place. All of the experiments were conducted with a view to keeping the artificially fertilized eggs of the oyster in receptacles of moderate capacity and under cover, so as to be readily accessible, while the water was either renewed on the embryo by hand or was aerated and kept in continuous circulation through an endless chain of vessels. Various forms of filters were tried without much success in the efforts to renew the water on the minute and delicate embryos, but these were unsatisfactory, and finally gave place to a system of vessels in which the same water was kept in continuous movement. On the 22d of July a lot of embryos placed in such an apparatus were found to have become attached to the sides of the vessels by the next day. This is apparently the first brood of artificially fertilized oyster embryos which are reported to have attached themselves, though it was not found practicable to keep them alive beyond a period of about three days.

It proved that it was not safe to alter the specific gravity of the water which was normal to the eggs and spermatozoa by artificial means, as such changes seemed to kill both. Putrescent action was prevented by using large volumes of water, into which a moderate proportion of eggs was introduced.

These developments, together with what had been learned during the seasons of 1879, 1880, and 1881, lead up to the attempt to utilize artificial fertilization with practical success in 1883.

In order to enable Mr. Ryder to investigate the alleged differences in the anatomy of the American oyster and the several European species and varieties. Mr. Blackford provided a quite complete collection of the latter, which furnished the basis of some important researches. Mr. Blackford also furnished several barrels of small seed-oysters to Mr. House, of Corinne, Utah, to be planted as an experiment in Great Salt Lake. No report of the result has, however, been furnished.

D.—ABSTRACT OF THE ARTICLES IN THE APPENDIX.

25.—CLASSIFICATION OF ARTICLES.

In the general Appendix to this report will be found a series of over forty separate papers treating upon matters related to the work of the Fish Commission. These are classified under six headings, as follows:

A.—GENERAL.

The first paper is by Lieut. Z. L. Tanner, illustrated by three plates, and gives an account of the Fish Hawk's work during the third year of its service. A similar paper by Lieut. W. M. Wood gives an account of the work done by the Lookout while under his command. A paper prepared from notes of the late F. S. Eastman, with six plates, illustrates the new Fish Commission car. Colonel McDonald discussed the subject of fish-ways. A foreign estimate of the United States exhibit at Berlin is reprinted from a German publication. Mr. Smiley has arranged for reference: (1) a list of the (1,817) principal lakes of the United States, with an index; and (2) a list in systematic order of the principal rivers of the United States, and containing nearly six thousand items.

B.—THE FISHERIES.

This contains papers on the whale fisheries, by F. C. Sanford and Thomas Southwell; extracts from the Scotch Fishery Board's report on the Scotch fisheries, apparatus, &c.; a history of the Tile fish, by Captain Collins, with a special index and two plates; and note on the preservation of nets and sails, by Prof. F. H. Storer, of Boston.

C.—NATURAL HISTORY AND BIOLOGICAL RESEARCH.

In this section are presented: (1) Notes on various species of sea birds which are used for bait, by Captain Collins, with one figure and an index; (2) a list of the fishes collected by the Fish Commission at Wood's Holl in 1881, by Dr. T. H. Bean; (3) a report on the Decapod crustacea of the Albatross dredgings in 1883, by Sidney I. Smith, with ten plates and an index; (4) a translation of V. Hensen's paper on the eggs of the plaice, flounder, and cod, with one figure; (5) an important contribution to the embryography of osseous fishes, by J. A. Ryder, with twelve plates and an index; (6) directions for preserving embryonic materials for microscopic analysis, by the same author; (7) notes upon the principal aquaria of Europe in 1875, by Professor Blake, of Yale College; and (8) some notes upon the marine fauna of the New England coast and Vineyard Sound, by Professor Verrill, of Yale College, with a special index thereto.

D.—The Oyster.

In continuation of the data introduced in the report of 1880 upon this subject will be found six papers, by Bouchon-Brandely, Brocchi, Winslow, Ryder, and Puységur. The first two are translations from the French and treat of French experiments. The three following articles indicate what is being done in this matter by our own investigators under the auspices of this Commission. Several illustrations accompany these papers.

E.—Propagation of Food-Fishes.

Under this head will be found detailed and statistical reports upon the work of the United States Fish Commission in propagating and distributing food-fishes, such as shad, herring, white-fish, trout, and several kinds of salmon, by F. N. Clark, Livingston Stone, Charles G. Atkins, W. M. Wood, Fred. Mather, M. McDonald, and Chas. W. Smiley. There is also a report by Mr. Mather upon eggs shipped to Europe.

Upon the subject of carp culture will be found a translation from the German of Karl Nicklas's observations upon artificial feeding of carp; a report by Chas. W. Smiley of the distribution in 1879 and 1880 of carp reared by the Fish Commission, and of the distribution in 1881, by M. McDonald.

F.—Miscellaneous.

This section contains a report by Capt. J. W. Collins upon a cruise of the Fish Hawk in Chesapeake Bay; an article by Prof. A. E. Verrill upon the physical characters of the continental border of the Gulf Stream as revealed by the Fish Hawk explorations, 1880–'82; a list of fishes propagated by the United States Fish Commission by Dr. T. H. Bean; and an alphabetical index of the names of the six thousand rivers of the United States treated under Appendix A by Chas. W. Smiley.

E.—SUPPLEMENT TO THE REPORT PROPER.

26.—LIST OF LIGHT-HOUSE KEEPERS RENDERING ASSISTANCE.

The following is a list of the light-houses (with their keepers) at which temperatures and occurrences of ocean fish have been observed during a portion or all of the present year:

List of light-houses on the Atlantic coast at which ocean temperatures have been taken during the year 1882, together with the number of monthly reports made at each one.

Petit Manan light-house, Petit Manan Island:	
George L. Upton, Millbridge, Me.	12
Mount Desert light-house, Mount Desert Rock:	
James A. Morris, Southwest Harbor, Me. (succeeded by Thomas Milan in October)	12
Martinicus Rock light-house, Penobscot Bay:	
William G. Grant, Martinicus, Me.	12

Seguin light-house, Seguin Island, Kennebec River:
Thomas Day, Hunnewell's Point, Me 12
Boone Island light-house:
Alfred J. Leavitt, box 808, Portsmouth, N. H 12
Minot's Ledge light-house, Cohasset Rocks, Boston Bay:
Frank F. Martin, Cohasset, Mass 12
Race Point light-house, Cape Cod Bay:
Heman F. Smith, Provincetown, Mass. (succeeded by James Cushman in December 12
Pollock Rip light-station, entrance to Vineyard Sound:
Joseph Allen, jr., South Yarmouth, Mass 12
Nantucket New South Shoal light-station, Davis New South Shoal:
Andrew J. Sandsbury, Nantucket, Mass 10
Cross Rip light-station, Vineyard Sound:
Luther Eldredge, Chatham, Mass 9
Buoy Depot, Government wharf, office inspector second division:
Benjamin J. Edwards, Wood's Holl, Mass 12
Vineyard Sound light-station, Sow and Pigs Rocks:
William H. Doane, 13 Milk street, New Bedford, Mass 11
Brenton's Reef light-station, off Brenton's Reef and Newport Harbor:
Charles D. Marsh, Newport, R. I 12
Block Island light-house, southeast end of Block Island:
H. W. Clark, Block Island, R. I 12
Bartlett's Reef light-station, Long Island Sound:
Daniel G. Tinker, New London, Conn 12
Stratford Shoals light-house, Middle Ground, Long Island Sound:
James G. Scott, Port Jefferson, N. Y 12
Fire Island light-house, south side of Long Island:
Seth R. Hubbard, Bay Shore, N. Y 12
Sandy Hook light-house, entrance to New York Bay:
James Cosgrove, 128 Rutledge street, Brooklyn, N. Y 12
Absecom light-house, Absecom Inlet:
A. G. Wolfe, Atlantic City, N. J 12
Five Fathom Bank light-station, off Delaware Bay:
Daniel Manlove, Cape May City, N. J. (succeeded by Wm. W. Smith in September) 12
Fourteen-Foot Bank light-station, Delaware Bay:
John Lund, Wilmington, Del. (succeeded by Ed. A. Howell, Delaware City, in June, 1882) 12
Winter-Quarter Shoal light-station, Chincoteague Island:
C. Lindermann, Chincoteague Island, Accomack County, Virginia 12
York Spit light-house:
James K. Hudgins, Port Haywood Va 7
Wolf Trap Bar, Chesapeake Bay, Virginia:
John L. Burroughs, New Point, Matthews County, Virginia 12
Stingray Point light-house:
George W. Crittenden, Sandy Bottom, Va. (succeeded by C. S. Lankford in March) 12
Windmill Point, mouth of Rappahannock River:
James I. Williams, Hookumfair, Va 12
Bodie's Island light-house, north of Cape Hatteras:
Peter G. Gallop, Manteo, Dare County, North Carolina 11
Cape Lookout light-house, Cape Lookout:
Deward Rumley, Beaufort, N. C 12

Frying-Pan Shoal light-station, Cape Fear:
David W. Manson, Smithville, N. C. (succeded by John D. Davis in October). 11
Rattlesnake Shoal light-station, off Charleston:
John McCormick, Charleston, S. C 12
Martin's Industry light-station, Port Royal Entrance:
John Masson, Port Royal, S. C 12
Fowey Rocks light-house, Fowey Rocks:
John J. Larner, Miami, Fla 12
Carysfort Reef light-house, Florida Reefs:
F. A. Brost, Key West, Fla 12
Dry Tortugas light-house, Loggerhead Key:
Robert H. Thompson, Key West, Fla 12

27.—LIST OF RAILROADS GRANTING BAGGAGE-CAR FACILITIES IN 1882.

During the present year a large number of railroads have accorded the facilities for carrying fish in baggage cars and for stopping trains at bridges so as to deposit young fish. The list is given herewith, and the most hearty acknowledgment made of their interest and co-operation.

Alabama Great Southern Railroad Company. Charles B. Wallace, superintendent, Chattanooga, Tenn.

Associated Railways of Virginia and the Carolinas. A. Pope, general passenger agent, Richmond, Va.

Atchison, Topeka and Santa Fé Railroad. W. S. Mellen, assistant general manager, Topeka, Kans.

Atlanta and West Point Railroad. A. J. Orme, general passenger agent, Atlanta, Ga.

Baltimore and Ohio Railroad Company. Thomas M. King, general superintendent Pittsburgh division; B. Dunham, superintendent Trans-Ohio division; W. M. Clements, master of transportation.

Boston and New York Air-Line Railroad Company. J. H. Franklin, superintendent, New Haven, Conn.

Boston and Albany Railroad. C. O. Russell, superintendent, Springfield, Mass.

Boston and Providence Railroad Company. A. A. Folsom, superintendent, Boston, Mass.

Burlington and Missouri River Railroad in Nebraska. G. W. Holdrige, general superintendent, Omaha.

Carolina Central Railroad. W. Q. Johnson, general superintendent, Wilmington, N. C.

Central Railroad of New Jersey. James Moore, general superintendent and engineer, Elizabeth, N. J.; F. S. Lathrop, receiver.

Central Railroad and Banking Company of Georgia. William Rogers, general superintendent, Savannah, Ga.

Central Vermont Railroad Company. J. W. Hobart, general superintendent, Saint Albans, Vt.

Charlotte, Columbia and Augusta Railroad Company. T. M. R. Talcott, general manager; A. Pope, general passenger agent, Richmond, Va.

Cheraw and Darlington, and Cheraw and Salisbury Railroads. J. F. Divine, general superintendent: A. Pope, general passenger agent, Richmond, Va.

Chesapeake and Ohio Railway Company. C. W. Smith, general manager, Richmond, Va.

Chicago, Rock Island and Pacific Railroad Company. A. Kimball, general superintendent, Davenport, Iowa.

Chicago and Alton Railroad. J. C. McMullin, general manager, Chicago, Ill.

Chicago, Saint Louis and New Orleans Railroad Company. W. H. Osborn, president; J C. Clarke, vice-president and general manager, New York.

Chicago and Northwestern Railway. I. D. Layng, general superintendent, Chicago, Ill.

Chicago, Burlington and Quincy Railroad Company. T. J. Potter, general manager, Chicago, Ill.

Chicago, Saint Paul, Minneapolis and Omaha Railroad, and North Wisconsin Railroad. Charles F. Hatch, general superintendent, Saint Paul, Minn.

Cincinnati, Hamilton and Dayton; Dayton and Michigan; Cincinnati, Hamilton and Indianapolis; and Cincinnati, Richmond and Chicago Railroads. L. Williams, general manager, Cincinnati, Ohio.

Cincinnati, Sandusky and Cleveland Railroad. D. W. C. Brown, general manager and superintendent, Springfield, Ohio.

Cleveland, Columbus, Cincinnati and Indianapolis Railway Company. E. B. Thomas, general manager, Cleveland, Ohio.

Cleveland, Mount Vernon and Columbus Railroad Company. G. A. Jones, receiver, Mount Vernon, Ohio.

Columbia and Greenville Railroad. T. M. R. Talcott, general manager, Richmond, Va.

Connecticut River Railroad. J. Mulligan, superintendent, Springfield, Mass.

Delaware and Chesapeake Railway. O. S. Sandford, superintendent, Easton, Md.

Delaware, Lackawanna and Western Railroad. Samuel Sloan, president, New York.

East Tennessee, Virginia and Georgia Railroad. John F. O'Brien, chief engineer and superintendent, Knoxville, Tenn.

European and North American Railroad. F. W. Cram, superintendent, Bangor, Me.

Fitchburg Railroad Company. John Adams, general superintendent, Boston, Mass.

Flint and Pere Marquette Railway. Sanford Keeler, superintendent, East Saginaw, Mich.

Florida Central Railroad Company. W. M. Davidson, superintendent, Jacksonville, Fla.

Fort Wayne and Jackson Railroad Company. M. D. Woodford, general superintendent, Jackson, Mich.

Galveston, Harrisburg and San Antonio Railroad Company. James Converse, general superintendent.

Georgia Railroad Company. E. R. Dorsey, general freight and passenger agent, Augusta, Ga.

Gulf, Western Texas and Pacific Railroad. M. D. Monserrate, general superintendent, Cuero, Tex.

Hannibal and Saint Joseph Railroad Company. W. R. Woodard, superintendent, Hannibal, Mo.

Hartford and Connecticut Valley Railroad Company. Samuel Babcock, president, Hartford, Conn.

Houston and Texas Central Railroad. G. Jordan, vice-president, Houston, Tex.

Indianapolis and Saint Louis Railroad Company. E. B. McClure, general superintendent, Indianapolis, Ind.

Illinois Central Railroad Company. Joseph F. Tucker, traffic manager, Chicago, Ill.

Jacksonville, Pensacola and Mobile Railroad. John P. Laird, superintendent, Tallahassee, Fla.

Kansas City, Fort Scott and Gulf Railroad; Kansas City, Lawrence and Southern Railroad. L. W. Towne, superintendent, Kansas City, Mo.

Kansas City, Saint Joseph and Council Bluffs Railroad Company. I. F. Barnard, general superintendent, Saint Joseph, Mo.

Keokuk and Saint Louis Line. J. H. Best, general freight and passenger agent, J. W. Smith, superintendent, Keokuk, Iowa.

Lake Shore and Michigan Southern Railroad. P. P. Wright, general superintendent, Cleveland, Ohio.

Little Rock and Fort Smith Railway. Theodore Hartman, general superintendent, Little Rock, Ark.

Louisville and Nashville Railroad. D. W. C. Rowland, general superintendent, Louisville, Ky.

Montgomery and Eufaula Railroad. William Rogers, general superintendent, Montgomery, Ala.

Marietta and Cincinnati Railroad. J. H. Stewart, receiver, Cincinnati, Ohio.

Memphis and Little Rock Railroad. E. K. Sibley, general manager, Little Rock, Ark.

Missouri Pacific Railway. A. A. Talmage, general manager, Saint Louis, Mo.

Mississippi and Tennessee Railroad. M. Burke, general superintendent, Memphis, Tenn.

Mobile and Ohio Railroad. A. L. Rives, general manager, Mobile, Ala.

Nashville, Chattanooga and Saint Louis Railway. J. W. Thomas, general superintendent, Nashville, Tenn.

New York, Lake Erie and Western Railroad. B. Thomas, superintendent of transportation, New York.

New York and New England Railroad Company. A. C. Kendall, general passenger agent; O. M. Shepard, superintendent of transportation, Boston; J. H. Wilson, vice-president.

New York, New Haven and Hartford Railroad Company. E. M. Reed, vice-president, New York.

New York, Pennsylvania and Ohio Railroad. P. D. Cooper, general superintendent, Cleveland, Ohio.

Northern Central Railway Company; Baltimore and Potomac Railroad; and Alexandria and Fredericksburg Railway. J. R. Wood, general passenger agent, Philadelphia, Pa.

Northeastern Railroad of Georgia. H. R. Bernard, superintendent, Athens, Ga.

Ohio and Mississippi Railway Company. W. W. Peabody, general superintendent, Cincinnati, Ohio.

Old Colony Railroad Company. J. R. Kendrick, superintendent, Boston, Mass.

Pennsylvania Company. D. W. Caldwell, general manager, Pittsburgh, Pa.

Pennsylvania Railroad Company. J. R. Wood, general passenger agent, Philadelphia, Pa.

Petersburg Railroad Company. R. M. Sully, general superintendent, Petersburg, Va.

Pittsburgh, Cincinnati and Saint Louis Railway Company. D. W. Caldwell, general manager, Columbus, Ohio.

Richmond and Danville Railroad. T. M. R. Talcott, general manager, Richmond, Va.

Richmond and Petersburg Railroad Company. Theo. D. Kline, general superintendent, Richmond, Va.

Richmond, Fredericksburg and Potomac Railroad Company. E. T. D. Myers, general superintendent, Richmond, Va.

Savannah, Griffin and North Alabama Railroad. William Rogers, general superintendent, Savannah, Ga.

Savannah and Memphis Railroad Company. W. C. Fowler, cashier, Opelika, Ala.

Savannah and Charleston Railroad Company. C. S. Gadsden, engineer and superintendent, Charleston, S. C.

Savannah, Florida and Western Railway Company. R. G. Fleming, superintendent, Savannah, Ga.

Seaboard and Roanoke Railroad Company; Raleigh and Gaston Railroad Company; Raleigh and Augusta Air-Line Railroad Company; Baltimore Steam Packet Company; Albemarle Steam Navigation Company. John M. Robinson, president, Baltimore, Md.

Southwestern Railroad of Georgia. William Rogers, superintendent, Macon, Ga.

South Carolina Railroad. John B. Peck, general superintendent, Charleston, S. C.

Saint Louis and San Francisco Railway. C. W. Rogers, general manager, Saint Louis, Mo.

Saint Louis, Iron Mountain and Southern Railway. H. M. Hoxie, general manager, Saint Louis, Mo.

Saint Paul, Minneapolis and Manitoba Railway. A. Manvel, assistant general manager, Saint Paul, Minn.

Texas and Pacific Railway Company. George Noble, general superintendent, Marshall, Tex.

Texas and New Orleans Railroad. J. F. Crosby, vice-president and general manager, Houston, Tex.

Union Pacific Railway. Thomas L. Kimball, assistant general manager, Omaha.

Virginia Midland Railway Company. W. M. S. Dunn, engineer and superintendent, Alexandria, Va.

Vandalia Line; Terre Haute and Indianapolis Railroad Company. D. W. Caldwell, general manager, Saint Louis, Mo.

Vicksburg and Meridian Railroad Company. E. F. Raworth, general superintendent, Vicksburg, Miss.

Wabash, Saint Louis and Pacific Railway. John C. Gault, general manager, Saint Louis, Mo.

Western and Atlantic Railroad Company. William MacRae, general manager, Atlanta, Ga,

Western North Carolina Railroad. James W. Wilson, president, Morganton, N. C.

Western Railroad of Alabama. Cecil Gabbett, general manager, Montgomery, Ala.

West Jersey Railroad Company, passenger department. L. P. Farmer, general passenger agent, Philadelphia, Pa.

Western Maryland Railroad Company. J. M. Hood, general manager, Baltimore, Md.

Wilmington and Weldon; and Wilmington, Columbia and Augusta Railroads. A. Pope, general passenger agent, Wilmington, N. C.; John F. Divine, general superintendent.

Wisconsin Central Railroad Company. F. N. Finney, general manager, Milwaukee, Wis.

28.—List of railroads that moved cars, and messengers to the number of five accompanying, at the rate of twenty cents a mile during the year 1882.

Alabama Great Southern Railway; Chattanooga, Tenn.
Atlanta and West Point Railroad; Atlanta, Ga.
Baltimore and Ohio Railroad; Baltimore, Md.
Chesapeake and Ohio Railway; Richmond, Va.
Chicago, Burlington and Quincy Railroad; Chicago, Ill.
Chicago and Northwestern Railway; Chicago, Ill.
Cincinnati, Indianapolis, Saint Louis and Chicago Railway; Cincinnati, Ohio.
Columbus, Hocking Valley and Toledo Railway; Columbus, Ohio.
East Tennessee, Virginia and Georgia Railroad; Knoxville, Tenn.
Georgia Railroad; Augusta, Ga.

Illinois Central Railroad; Chicago, Ill.
Louisville and Nashville Railroad; Louisville, Ky.
Marietta and Cincinnati Railroad (now Cincinnati, Washington and Baltimore); Cincinnati, Ohio.
Minneapolis and Saint Louis Railroad; Minneapolis, Minn.
Nashville, Chattanooga and Saint Louis Railway; Nashville, Tenn.
New York and New England Railroad; Boston, Mass.
New York, New Haven and Hartford Railroad; New York, N. Y.
Pennsylvania Railroad; Philadelphia, Pa.
Pennsylvania Company:
    Jeffersonville, Madison and Indianapolis Railway; Louisville, Ky.
    Pittsburg, Cincinnati and Saint Louis Railway;
    Pittsburg, Fort Wayne and Chicago Railway;
Petersburg Railroad; Petersburg, Va.
Raleigh and Gaston Railroad; Raleigh, N. C.
Richmond and Danville Railway; Richmond, Va.
Richmond and Petersburg Railroad; Richmond, Va.
Richmond, Fredericksburg and Potomac Railroad; Richmond, Va.
Terre Haute and Indianapolis Railroad; Terre Haute, Ind.
Virginia Midland Railway; Alexandria, Va.
Western Railroad of Alabama; Montgomery, Ala.

APPENDIX A.

GENERAL.

I.—REPORT ON THE WORK OF THE UNITED STATES FISH COMMISSION STEAMER FISH HAWK FOR THE YEAR ENDING DECEMBER 31, 1882, AND ON THE CONSTRUCTION OF THE STEAMER ALBATROSS.

By Lieut. Z. L. Tanner, U. S. N., Commanding.

At the close of my last report, the Fish Hawk was at the United States navy-yard, Washington, D. C., where she remained until February 25. During this time, the crew were employed in cleaning and refitting the ship in preparation for the season's work. On that date, there were received on board 1,000,000 cod eggs from the United States Fish Commission, which were placed in spawning pans with artificial sea water for transportation to Chesapeake Bay, when they were to be placed in the cones for hatching, using water from the bay. About 75 per cent. of the eggs appeared to be alive when they were brought on board.

At 12.50 p. m. on the date above mentioned, with Captain Collins, an experienced fisherman, on board, we left the navy-yard and steamed down the Potomac River; at 10.45 p. m., anchored in Cornfield Harbor.

The cod eggs were distributed among three cones and one glass aquarium, the water of the bay and river being used; they sank to the bottom, showing that the specific gravity was much less than that of sea water. They were then treated as shad eggs, the feed water being admitted at the base, and discharged through the gauze at the top of the cone in the usual manner. The aquarium was covered with one thickness of white bunting, which prevented oscillation by the motion of the vessel, and allowed the water to escape freely. A quarter-inch glass tube was introduced as a feed-pipe, and the discharge took place through the bunting cover. The temperature of the water was 40° F. at the surface, and 41° F. in the cones.

On the 26th, about 60 per cent. of the eggs seemed to be alive, but little or no development had taken place since the day before. They sank promptly, and the ordinary feed for shad hatching would not keep them at the surface.

When the eggs were received on board, they were 0.06 of an inch in diameter, germinal disk, $\frac{1}{125}$ of an inch, the live eggs seeming to be healthy. During this day, the germinal disk appeared to have contracted, and the proportion of dead eggs rapidly increased.

Gill nets were set at different places on the 26th, and taken up on the 27th. Large numbers of medusæ were found in them, but no fish.

On the morning of the 27th, there were but few cod eggs alive, and they were in an abnormal condition, the germinal disk distorted, shrunk, and shriveled.

At 1.50 p. m. on the 27th, got under way, and examined the oyster beds between Saint Jerome's Creek and Point No Point. Scattering oysters were found in 3 fathoms and upwards, but none at a less depth, large quantities of grass being brought up. At 3 p. m., started for Barren Island, the cutter with nets having been sent on ahead. Arriving off the latter place, the nets were sent in 20 fathoms, and we came to anchor opposite Drum Point, Patuxent River.

At 9.10 p. m. no good cod eggs were to be found in the cones.

On the morning of the 28th the nets were taken up, and twenty-two young menhaden were found in them. These measured from 3 to 8 inches in length, and were all caught by the mouth, the fine twine entering between the upper and lower jaw, after which the fish became more thoroughly entangled in the meshes.

At 10 a. m. got underway, and lowered the dredge in 6 fathoms of water, Drum Point bearing NE., and one-half a mile distant, to try the bottom. Six hauls of the dredge and trawl were made between this position and 2 miles N. N.E. of Smith's Point, the depth varying from $2\frac{3}{4}$ to 25 fathoms. Brought up small numbers of crawfish, young herring, menhaden, and shrimp. Anchored for the night in Cornfield Harbor.

On the 1st of March all the dead cod eggs were thrown overboard and the tank, cones, &c., cleaned and properly cared for.

On the 2d, we examined the oyster-bed between Smith's Creek and Cornfield Point. We found the bivalves few in number and very small. The average was about a bushel of marketable oysters at each haul.

At 8.15 took up nets set off Point Lookout on the evening of the 28th. They were considerably fouled on account of the rough water, but received no material damage. There were large numbers of medusæ in the nets, but no signs of fish.

At 9.40 stopped off Smith's Point, and commenced taking up the nets set on the 28th. Two nets were entirely destroyed, one slightly damaged, and one uninjured. They broke adrift from the weather anchor, and drifted afoul of the lee mooring, where they became twisted and tangled by tide and sea. They were more or less injured also by dragging over oyster shells on the bottom. There were no signs of fish; nothing, in fact, but a little coral and a few oysters.

At 11.20 lowered the dredge to ascertain if there were any life in the sand and mud of the bottom, Smith's Point bearing S. by W. $\frac{1}{2}$ W., $1\frac{1}{2}$ miles distant, depth of water 11 fathoms. Four casts of the trawl and dredge were taken between this position and 1 mile S. S.W. of the southern point of Tangier Island, the depth varying between $9\frac{1}{2}$ and 20 fathoms. Oyster shells, small shrimp, a few worms, and worm tubes, small shells, &c., were brought up.

On the 3d we took up the nets which had been set the night before, and found them full of grass, coral, &c., but no fish. The tide had drifted them somewhat out of place.

As soon as the nets were on board, we started for Fortress Monroe for provisions, leaving there at 2.30 p. m. for Cherrystone Inlet. At 4.30 set four nets in 25 fathoms of water, Cherrystone Light-house bearing E. by S., and 2 miles distant. At 6.20 p. m. arrived at the wharf, where we made fast for the night.

As it was too rough to take up the nets on the 4th, we remained at the wharf taking the opportunity to overhaul and repair fishing gear. The engineers department made some repairs on the boilers in Kimberly's oyster-packing establishment. The nets were taken up during the afternoon of the 5th and found to be badly bunched together, but they contained 50 dogfish and 1 menhaden about 6 inches long.

The stomachs of 20 dogfish were preserved in alcohol; the menhaden was also preserved and 6 dogfish were placed on the ice to be transferred to the Museum. The ovaries of the dog-fish were not at all developed.

On the 6th, the nets set the day before were taken up but they contained no fish.

At 9 a. m. lowered the trawl in 25 fathoms of water, sandy bottom, and dragged into 12 fathoms, Cherrystone Light-house bearing E. by N., distant 2 miles. Three hauls of the trawl were taken during the day between this position and one at which the same light-house bore SE. by E. ¼ E., distant 3 miles, the depths varying between those given above.

At 10 a. m. steamed ahead full speed for Saint Jerome's Creek, where we arrived at 3.40. Sent on shore for the mail, and at 4 p. m. started for Annapolis, having received instructions to that effect. At 10.35 p. m. anchored off the harbor.

At 9 a. m. on the 7th got under way and steamed up the Severn River, anchoring off the city wharf, Annapolis. Remained here until 9.30 a. m. on the 11th, at which time got under way and steamed to the deep water off Kent Island for the purpose of extending the examination of the bottom in maximum depths. At 9.50 a. m. cast the trawl in 14 fathoms, Thomas Point Light-house bearing W. S.W. ¼ W., distant 2 miles. Seven casts of the dredge and trawl were made during the day between this position and one at which the same light-house bore N. by W. ½ W., distant 4¾ miles, the depth varying from 9 to 18 fathoms. We tried the oyster-dredge at several places along the coast of Kent Island with indifferent success, and at 4.20 p. m. anchored off the city wharf at Annapolis.

At 8.55 a. m. on the 13th, got under way and steamed over to Kent Island to continue the examination of the bottom in that locality. At 9.45 cast the trawl in 14 fathoms, Sandy Point light-house bearing N. by W. ¼ W., and distant 3½ miles. Three casts of the trawl were taken between this position and one at which the same light-house bore NW. ¼ W., distant 2¼ miles, the depth varying from 11 to 15 fathoms.

At 11.45 a. m. lowered the oyster-dredge on the banks off the mouth of Magothy River, where several schooners were dredging. Worked about forty-five minutes, averaging about 1 bushel of marketable oysters to 15 of dead shells, the bank having been pretty well dredged out. At 12.40 p. m. started for Annapolis, arriving at 1.35 p. m.

On the 21st steamed out with a party of the Maryland legislature and trawled and dredged in the bay to show them how the work was carried on.

On the 22d left Annapolis, and on the 23d arrived at Washington.

On the 30th coaled ship. From this date till the 10th of April we remained at the navy-yard, making preparations for the hatching season. On the latter date, proceeded to Quantico, Va., and made fast to the railroad wharf.

From the 10th of April until the 10th of May we remained at this port engaged in hatching, with results as shown by the accompanying table. On the latter date proceeded to Washington, and made fast to the wharf at the navy-yard. On the 11th of May sent to the Armory for transportation 2,000,000 young herring and 600,000 young shad. On the 12th put overboard alongside of the ship 23,000 young shad. On the 14th received from the Fish Commission steamer Lookout, 40,000 shad eggs which were placed in cones. On the 16th transferred to Master W. C. Babcock, U. S. N., 200,000 young shad for transportation.

On the 22d we left Washington for Havre de Grace, Md., arriving at noon the following day. The vessel was moored at the pier at Battery Station, and her boats, with spawn-takers, sent to the various fishing grounds. Active preparations had been made during the season to haul a seine for the purpose of taking shad and other fish, and confining them in an inclosure until ready for spawning. The first haul was made on the 20th instant, and the fish turned into the pool. Such of the crew of this vessel as were required, were detailed to assist at the seine-hauls and the steam cutter was frequently used for towing the seine-boat.

Hauls were made daily, and the fish transferred to the pool, where a small seine was hauled usually once a day, and the fish examined. Those that were in condition for spawning were turned over to the spawn-takers, and the unripe fish were returned to the pool.

About 700 shad were placed in the inclosure during the season and subjected to the rough handling of the small seine and manipulation of spawn-takers once a day for three weeks or more without apparent injury; it was observed, however, that wounds did not heal, but became covered with fungus.

Although the experiment was made too late in the season to demonstrate the practicability of procuring spawn in that manner; it was clearly shown that, with careful handling, shad could be penned for a considerable period. Quite a number remained in the pool after the close of the hatching season, and subsequently began feeding; at least that was the supposition, as four were taken with a hook and clam bait

during the month of August. Shad were seen in the pool as late as November, but were in poor condition and almost covered with fungus.

The results of seining at Battery Station will be found in the table appended.

On the 14th of June we coaled ship at Havre de Grace, and on the 15th left for Washington, arriving on the 16th.

The principal improvement introduced in shad-hatching during the present season on board the Fish Hawk, as shown in Plate 1. Fig. 1, is a vertical sectional view of the base of hatching-cone *a a*, with base-ring *b b* of cast brass, and goose-neck *c*, also of cast brass.

The improvement referred to consists of the small brass cone *d d*, introduced into the base of the hatching-cone in place of the wire gauze formerly used, for the double purpose of strainer and guard, to prevent the eggs from falling into the goose-neck.

The inverted conical surface is $\frac{1}{16}$ of an inch smaller than the base-ring *b b*, and has four ribs $\frac{1}{32}$ of an inch thick, equidistant upon its periphery, which rest on the base-ring above mentioned, forming a channel between the ribs through which the water flows from the goose-neck to the cone.

Fig. 2 is a plan view of the base-ring *b b*, the small cone *d*, the ribs *e e e e*, and the water channel *f f f f*. The hatching capacity of the cones was nearly doubled by the use of this cone, and the labor required in attending them during the hatching process was greatly reduced, as neither goose-neck nor cone required removal for cleaning.

The aerators described in my last report were used during the season, and in case it became necessary to crowd the hatching cones with eggs it would be of great service.

On the morning of June 19 we left the navy-yard with two United States Fish Commission barges in tow, destined for Saint Jerome's Creek. We encountered a gale in the Lower Potomac which damaged one of the barges somewhat and forced us to seek a harbor in Smith's Creek, where we remained till the morning of the 21st, when, the weather having moderated, we went to the station at Saint Jerome's and commenced the task of hauling the barges out on the beach.

The machinery barge weighed 65 tons and the other 45, which we found too much for any purchase we had on board, and as the necessary blocks could be found at Annapolis, we left at once for that place, borrowed what we required from the Santee and returned at 2 p. m. the following day.

Work was resumed at once, and the barges were on the beach and blocked up on the 24th. We then went to the wharf and took on board a quantity of stores, which we delivered at the station, then left for Annapolis to return the blocks borrowed, arriving at 11 p. m. Remained at anchor during the following day, Sunday, returned the blocks on Monday morning, and at 7.45 a. m. left for Point Lookout wharf, where we took in stores for Saint Jerome's. Returned to that place and anchored for the night.

The stores were landed the following morning and a working party sent on shore to adjust the machinery of the barge.

Nitrate of silver tests were made for salt in the house and barge drive-wells at Saint Jerome's. Its presence was clearly shown in the cloudiness, bearing a resemblance to skimmed milk. It was not, however, apparent to the taste.

The afternoon of the 28th and morning of the 29th we were occupied in swinging ship to adjust the compasses. On the latter date we left for Washington, arriving at the navy-yard on the 30th, where we remained until the 8th of July, making preparations for the season's work of deep-sea exploration.

At 6.10 a. m. on the latter date we left the navy-yard for Wilmington, Del., to deliver anchors and chains, dinghy, galley, and other parts of the equipment of the new Fish Commission steamer Albatross, building at that place.

At 8.30 a. m., on July 10, arrived at the Pusey & Jones Works, Wilmington, discharged freight for the Albatross, and at 10 a. m. the following day left for Washington by way of Havre de Grace and Baltimore.

We arrived at Havre de Grace at 7.35 a. m. on the 13th; coaled ship, took on board a hoisting engine, launches, boiler, &c., from Battery Station, and at 6.10 a. m. on the 14th left for Baltimore, where we took on board three car-loads of material for a water-tank.

At 3.40 p. m. left for Saint Jerome's, but finding a heavy swell in the bay were obliged to seek a harbor in the mouth of the Patuxent River for the night. On the following morning at daylight we got under way, arriving at Saint Jerome's at 8.30 a. m. Discharged the freight and left for Washington at 5.30 p. m., arriving at the navy-yard at 11.20 a. m., July 16. We remained here until the 21st, preparing for the season's work of deep-sea exploration.

At 1.10 p. m. on that date left Washington for Wood's Holl, arriving at 6.10 a. m. on the 24th. Landed outfit, &c., for the Commission, took on board dredging outfit and completed all arrangements for deep-sea work.

At 3 p. m. on August 1 we left for a dredging trip, anchoring inside of Monomoy Point for the night.

At 5.10 the following morning got under way, and at 7.34 cast the trawl in 55 fathoms of water, Nausett Beacons bearing NW. ¼ N., distant 10 miles. Work was continued from that point to the Highland Lights. Seven hauls were made during the day, the depth varying from 28 to 84 fathoms.

At 2.55 p. m. started for Provincetown, arriving at the latter place at 6 p. m., and made fast to the wharf for the night.

At 5.30 on the morning of the 3d left the harbor, and at 6.05 put the trawl over in 35 fathoms, Race Point Light-House bearing S. 33° E., distant 2 miles. Six hauls were made during the day between this

point and the Highland Lights. At 12.20 p. m. started for Wood's Holl, arriving at 7.55 p. m.

This trip was made for the purpose of re-examining certain localities in the vicinity of Provincetown and Chatham, and investigating certain places in the vicinity of Nausett Lights, not previously visited.

The naturalists were engaged in the laboratory in examining and preserving specimens, and in work about the shores until the 10th, when at 5 p. m. we left the harbor for an off-shore trip. At 5.30 a. m. on the 11th the trawl was cast in 65 fathoms, latitude 40° 03′ N., longitude 69° 44′ W. Eight hauls of the trawl were made during the day between this position and latitude 39° 53′ N., longitude 69° 43′ W., the depth varying from 65 to 349 fathoms. At 5.55 p. m. started for port, arriving at 7.30 on the morning of the 12th. During the trip the weather was clear and pleasant, with light southerly wind.

On the 14th steamed to New Bedford, coaled ship, and returned the following day.

On the 18th eight hauls of the trawl were made in Vineyard Sound for the purpose of re-examining certain localities.

The naturalists were engaged in the laboratory until the 21st, when at 6.40 p. m. we left the harbor for an off-shore trip. At 5.58 the following morning, in latitude 40° 02′ N., longitude 70° 35′ W., depth 116 fathoms, a trawl line was set for tile-fish. At 6.12 cast the trawl in the same vicinity. At meridian the fishing party returned, having caught several hake, large skate, and other fish, but no tile-fish. Twelve casts of the trawl were made between the position given above and latitude 40° 03′ N., longitude 70° 45′ W., the depth varying from 70 to 245 fathoms. During the day the weather was clear and pleasant, with a light breeze from east to southeast. Whales and porpoises were seen. At 6.50 p. m. started for port, arriving at 5.15 on the morning of the 23d.

At 3 p. m. on the 25th left port for an off-shore trip, passing out through the Muskegat Channel. At 6.32 the following morning the trawl was cast in 97 fathoms, latitude 40° 08′ N., longitude 68° 48′ W. Seven casts of the trawl were made during the day between this position and latitude 40° 03′ N., longitude 68° 56′ W., the depth varying from that above given to 787 fathoms. At 6.50 p. m. started for port, arriving at 9.40 the following morning.

At 9 on the morning of the 28th the United States steamer Tallapoosa arrived, having on board the Hon. W. E. Chandler, Secretary of the Navy, and chiefs of bureaus. At meridian we left the harbor with Professor Baird, the Secretary, and the chiefs of bureaus, for a short trip to show the manner of working the various apparatus used on board. Three casts of the dredge and trawl were made in Vineyard Sound, and at 4.30 p. m. we returned to Wood's Holl. The Tallapoosa left the harbor at 9.15 the next morning.

The naturalists were employed in the laboratory until September 2, when at 11.10 we left the harbor and steamed to No Man's Land. A party was sent on shore to examine a reported rock formation, but nothing of the kind was found. Five hauls of the dredge were made in this vicinity, and at 3.35 started for port, arriving at 6.07 p. m.

At 9.30 a. m., September 6, the United States steamer Despatch, having on board the President of the United States, and accompanied by the Fish Commission steamer Lookout, arrived in the harbor. At meridian we left the harbor with the President, Professor Baird, and others on board. To show the former the manner of working the various apparatus, three hauls of the trawl and dredge were made in Menemsha Bight. We reached port at 5.55 p. m., when the President returned to the Despatch. At 5 the next morning the Despatch, with the President on board, got under way and left the harbor.

At 3.30 p. m. on the 7th we left for an off-shore trip. From 8 to 9 p. m. we were steaming through a school of fish. They were first sighted about 12 miles to the southward of No Man's Land. At daylight the following morning the coast-survey steamer Blake was sighted.

At 6 o'clock cast the trawl in 176 fathoms, latitude 39° 40′ N., longitude 71° 52′ W. Eight hauls of the trawl were made during the day between this position and latitude 39° 33′ N. longitude 72° 06′ W., the depth varying from 168 to 452 fathoms. During the last haul the trawl net parted from the frame and was lost. The cause was an overload of blue mud which would not wash through and tore the net from the frame.

At 7.30 p. m. started for port, arriving at 10.35 the following morning.

On the 11th we steamed to New Bedford and coaled ship. The weather was cloudy and rainy during the morning, ending with a fresh gale from the southeast to east. On the 13th we returned to Wood's Holl.

We were detained in port by unfavorable weather until 5 p. m. on October 3, when we left for an off-shore trip.

At 6.45 the next morning a fishing party left the ship and set a trawl line in 99 fathoms, latitude 40° N., longitude 70° 37′ W., for the purpose of taking tile-fish.

At 6.30 cast the trawl in 140 fathoms, latitude 39° 58′ N., longitude 70° 37′ W.

At 2 p. m. the fishing party returned on board, having taken a large number of hake, skate, and other species, but no tile-fish. Over these grounds where they had been invariably taken before we found no trace of them during the present season. Six hauls of the trawl were made during the day between the position given above and latitude 39° 52′ N., longitude 70° 30′ W., the depth varying from 115 to 554 fathoms.

At 6 p. m. stated for port, arriving there at 6 a. m. on the 5th. This

was the last trip of the season, and preparations were then made for leaving the station. During the 9th and 10th specimens and other articles were received on board for transportation to Washington.

The dredging apparatus worked satisfactorily during the season, and no changes suggested themselves except in the method of registering the Negretti & Zambra deep-sea thermometer.

The Tanner case, described in my report of last year, is all that can be desired in the depths usually sought by the Fish Hawk; but, in anticipation of more extended explorations on board the Albatross, we considered it necessary to devise some method of registering in deep water without the necessity of waiting for the descent of a messenger.

The propeller on the Sigsbee water bottle suggested a simple and reliable method of reversing at any desired depth and would permit the use of any number of instruments in series.

I called the attention of Passed Assistant Engineer William L. Bailie to the matter, and he devised the plan shown on Plate II. Fig. 1 shows the instrument clamped to the sounding wire ready for use; Fig. 2 shows a front view of the case, and Fig. 3 a vertical sectional view of the Bailie attachment, which consists of the propeller and slip-hook inclosed in a metal case which screws to the upper end of the Tanner case, the slip-hook having been removed for the purpose.

To use the thermometer, clamp it to the sounding wire, as shown in Fig. 1, and the action of the propeller will close the hook and retain the wire during the descent. As soon as the ascent is commenced the propeller is set in motion, bringing the screw in the upper end of the spindle into action, gradually raising the propeller until the small part of the spindle at the lower end (Fig. 3) allows the hook to open, releasing the wire, when the thermometer capsizes and registers the temperature by breaking the column of mercury.

The drift or distance which the thermometer must move through the water before capsizing is regulated by a set screw, and can be varied at pleasure between the limits of 3 and 10 fathoms.

Later in the season we received several of the Magnaghi improved frames which, also, depended upon a propeller for reversing. They were not well adapted for use on sounding wire, and were not, therefore, much used.

The frame above mentioned is the device of Commander Magnaghi, of the Italian Navy. The following description is taken from the advertisement of Messrs. Negretti & Zambra.

NEGRETTI & ZAMBRA'S PATENT IMPROVED-FRAME STANDARD DEEP-SEA THERMOMETER.

"The apparatus will be best understood, short of inspection, by reference to Plate III (Nos. 1 and 2). A is a metallic frame in which the case B containing the thermometer is pivoted upon an axis, H, but not

balanced upon it. C is a screw-fan attached to a spindle, one end of which works in a socket, D, and on the other end is formed the thread of a screw, E, about half an inch long, and just above it is a small pin or stop, F, on the spindle. G is a sliding stop-piece against which the pin F impinges when the thermometer is adjusted for use. The screw E works into the end of the case B the length of play to which it is adjusted. The number of turns of the screw into the case is regulated by means of the pin and stop-piece. The thermometer in its case is held in position by the screw E, and descends into the sea in this position (Fig. 1), the fan C not acting during the descent because it is checked by the stop F. When ascent commences the fan revolves, raises the screw E, and releases the thermometer, which then turns over and registers the temperature of that spot, owing to the axis H being below the center of gravity of the case B, as adjusted for the descent. Each revolution of the fan represents about 10 feet of movement through the water upward, so that the whole play of the screw requires 70 or 80 feet ascent; therefore the space through which the thermometer should pass before turning over must be regulated at starting. If the instrument ascends a few feet by reason of a stoppage of the line while attaching other thermometers, or through the heave of the sea, or any cause whatever, the subsequent descent will cause the fan to carry back the stop to its initial position, and such stoppages may occur any number of times provided the line is not made to ascend through the space necessary to cause the fan to release the thermometer. When the hauling-in has caused the turn over of the thermometer, the lateral spring K forces the spring L into a slot in the case B and clamps it (as seen in Fig. 2) until it is received on board, so that no change of position can occur in the rest of the ascent from any cause. The case B is cut open to expose the scale of the thermometer, and is also perforated to allow the free entry of the water.

"The construction of the thermometer will be understood by reference to Fig. 3. The bulb is cylindrical, and mercury is the thermometrical fluid. The neck of the bulb is contracted at A, and upon the shape and fineness of this contraction the success of the instrument depends. Beyond A the tube is bent, and a small reservoir is formed at B. At the end of the tube a small receptacle, C, is provided. When the bulb is downward it contains sufficient mercury to fill the tube, and a part of the reservoir C, if the temperature is high, leaving sufficient space for the expansion of the mercury. In this position no scale would be possible, as the apparent movement of the mercury would be confined to the space C. When the thermometer is held bulb upward, the mercury breaks off at A, and by its own weight flows down the tube, filling C, and a portion of the tube above. The scale accordingly is made to read upward from C. To set the thermometer for observation it is only necessary to place it bulb downward, then the mercury takes the temperature just as an ordinary thermometer. Whenever the exist-

ing temperature is required, all that has to be done is to turn the thermometer bulb upward and keep it in this position until read off. The reading may be taken any time after."

At 11.55 a. m. on the 12th, left for Washington by way of Bristol R. I., and anchored in the latter port at 5.30 p. m. On the 16th a steam cutter and steam life-boat, built by the Herreshoff Company for the Fish Commission steamer Albatross, were received on board for transportation to Wilmington, Del. We were detained by fog until 4.15 p. m. on the 17th, when we got under way and steamed out of the harbor. The fog shutting down thick, we anchored at 5.20 near Coddington Harbor, Narragansett Bay, where we remained until 11.40 the following morning, when we got under way and steamed to Newport, where we anchored, waiting for favorable weather. At 6.25 on the morning of the 19th, got under way for New York. The weather was cloudy and rainy, with a moderate to brisk breeze from the northward.

At 4.35 p. m. we anchored for the night near Penfield Reef, Long Island Sound. At 5.30 the following morning got under way and arrived at the navy-yard, New York, at 11.10 a. m. At 11 a. m. on the 21st, left the navy-yard and steamed down the harbor. Finding a heavy swell outside and weather unfavorable, we anchored near Sandy Hook for the night. On the afternoon of the 22d we got under way and steamed to Perth Amboy, and on the following day coaled ship. On October 21, there were fresh northerly winds and passing clouds. At 4.45 p. m. got under way and proceeded to sea. Passed Cape Henlopen at 7.55 the following morning, and arrived at Wilmington, Del., at 6.20 p. m.

The boats were delivered to the Albatross on the 26th and at meridian on the 27th, we left for Washington, arriving at 10.30 a. m. on the 29th. Specimens and other articles consigned to the National Museum were delivered on the 30th, 31st, and November 1. The crew were actively employed in refitting ship.

On the 10th of November I received orders from the Navy Department detaching me from the command of the Fish Commission steamer Fish Hawk, and ordering me to report to the Commissioner of Fish and Fisheries for the command of the steamer Albatross.

Received orders from the Commissioner to retain temporary command of the former vessel until the reporting of my relief, and on the 20th turned over the command to Lieut. W. M. Wood, U. S. N.

My connection with the Albatross has been more or less intimate from her inception. On the 13th of March, 1882, I was ordered by the Navy Department to special duty in connection with her construction in addition to my regular duty in command of the Fish Hawk. Passed Assistant Engineer George W. Baird, U. S. N., was also ordered to the same duty in addition to his other duties and rendered great service, especially in connection with the special machinery and appliances required on board.

The contract for the hull and engines was closed on March 28, the

Pusey & Jones Company agreeing to complete her according to the specifications within six months from date, in consideration of the sum of $135,800. Work was commenced at once and pushed forward vigorously. Mr. Baird proceeded to Wilmington in compliance with his orders and I visited the place as often as my other duties would allow.

An appropriation of $45,000 had been made for the outfit, which was to include special machinery for sounding and dredging, electric lighting, ventilation, &c.

The vessel was launched on the 19th of August, and, according to the terms of the contract, was to be completed on the 28th of September. As various delays occurred after launching, many of which were caused by work outside of the contract, which it was necessary to have done at certain stages of her construction, the builders requested, and were granted, an extension of time.

Work was pushed forward as rapidly as possible, and on the 29th of December we left the builders' yard and anchored in the Delaware, preparatory to a trial trip on the following day. Many things were incomplete, and large gangs of mechanics were at work on board. We would not have left at this time had we not been apprehensive of an ice blockade, and it was desirable to have the vessel in Washington as soon as practicable.

At 8.30 a. m. on the 30th Mr. Charles W. Copeland, constructing engineer, Mr. William G. Gibbons, president of the Pusey & Jones Company, and others came on board to witness the trial trip. At 9.45 a. m. we got under way and steamed down the river for a trial under the direction of the builders.

At 2.30 p. m. Mr. Copeland expressed himself as satisfied with the trial, and at 3 p. m. left the ship in a tug, which also took the mechanics and others not belonging to the ship back to Wilmington. We then proceeded to sea, bound for Washington, D. C.

The weather was cloudy, and during the night we had a fresh breeze from the southeast, with heavy swell. The motions of the vessel were remarkably easy. The 31st was clear and cold, with a moderate breeze from northwest. At 10 a. m. passed Cape Charles. At 1.30 p. m. we swung ship under steam, observing azimuths for compass deviation, and at 11.30 p. m. anchored off Blackistone Island.

The engines worked satisfactorily during the trip, considering the fact that everything was new. Many of the valves and joints were leaky, and there were some quite extensive leaks in the boilers; but the greatest trouble was with the reversing gear, which made it impossible to work the engines with any degree of certainty. This, however, can be remedied with but little expense.

The following officers were attached to the ship at this date, viz:

Z. L. Tanner, lieutenant, U. S. N., commanding.

Seaton Schroeder, lieutenant, U. S. N., executive officer and navigator.

S. H. May, lieutenant, U. S. N.
A. C. Baker, master, U. S. N.
R. H. Miner, midshipman, U. S. N.
J. H. Kidder, surgeon, U. S. N.
George H. Read, paymaster, U. S. N.
George W. Baird, passed assistant engineer, in charge of machinery.

Petty officers.—Samuel H. McAvoy, machinist; John Hawkins, machinist; H. H. Walker, machinist; George B. Till, yeoman; William A. McDowell, master-at-arms; W. F. Lee, paymaster's yeoman; N. B. Miller, apothecary; and a crew of twenty-seven men.

Memoranda of seine hauls, Battery Station, May 20 *to June* 13, 1882, *inclusive.*

Date.	Kind of seine.	Shad taken.	Herring taken.	Perch taken.	Rock taken.	Shad eggs.	Remarks.
1882.							
May 20	Large seine...	4	700	500	0	0	One-quarter flood.
22	....do	70	800	1,500	1	0	One-half flood.
23	....do	150	2,000	1,000	1	....	Strong current.
24	....do	100	1,000	300	0	0	Young flood.
25	... do	48	600	300	0	0	
26	....do	100	500	300	....	....	
26	Pool	28	(*)	(*)	....	....	
29	....do	100	1,000	....	0	0	Freshet in river.
30	....do	75	....	....	....	0	Do.
June 2	Large seine...	27	400	200	0	0	One hour flood.
3	....do	12	300	200	0	0	
3	Pool	100	....	....	....	0	Pool hauled after dark.
5	Large seine...	16	....	....	....	0	One scale carp 2 lbs. (?)
6	....do	47	....	....	....	0	
6	Pool	90	....	....	....	30,000	
7	Large seine...	26	300	200	4	5,000	Milt of shad hard.
7	Pool	100	....	....	....	117,000	Five ripe females.
8	Large seine..	47	100	....	10	0	
8	Pool	160	....	....	....	317,000	Eleven females and twelve males.
9	Large seine...	26	50	200	14	0	
9	Pool	75	....	....	....	117,000	Six males, six females.
10	Large seine...	26	30	300	8	0	
12	....do	6	30	500	26	0	
12	Pool	100	....	....	....	25,000	Two males and two females.
13	Large seine...	6	20	400	39	0	
	Total	1,539	7,830	5,900	103	611,000	

* Large numbers of herring and perch; seine hung.

Record of fish hatching on board the United States Fish Commission Steamer Fish Hawk, season of 1882, *April* 12 *to June* 12, *inclusive.—Lieut. Z. L. Tanner, U. S. N., commanding.*

Date.	Station.	Fishery.	Kind of fish.	Number. Males.	Number. Females.	Number. Eggs taken.	When deposited.	Number deposited.	Where deposited.	State of water.	Tide.	Remarks.
1882. April 12	Quantico Creek, Virginia	Stump Neck	Herring	3	2	40, 000	Apr. 20–21	39, 500	Quantico Creek	Muddy	Low water	
12	do	do	do	3	3	100, 000	Apr. 20–21	99, 500	do	do	do	
12	do	do	Perch	1	3	40, 000	Apr. 20–21	30, 000	do	do	do	
13	do	do	Herring	3	4	250, 000	Apr. 20–21	248, 500	do	do	do	
13	do	Freestone Point	do	2	3	50, 000	Apr. 20–21	45, 500	do	do	do	
14	do	Stump Neck	do	3	3	300, 000				do	do	Killed by cold water.
14	do	Freestone Point	do	4	5	300, 000				do	do	Do.
14	do	Budd's Ferry	do	3	3	500, 000				do	do	Do.
14	do	Stump Neck	do	2	2	100, 000				do	do	Do.
14	do	Budd's Ferry	do	9	5	400, 000				do	High water	Do.
14	do	do	do	5	4	500, 000				do	Low water	Do.
14	do	Stump Neck	do	3	2	100, 000				do	do	Do.
15	do	Freestone Point	do	12	11	1, 200, 000				do	do	Do.
15	do	Budd's Ferry	do	7	6	80, 000				do	do	Do.
15	do	Stump Neck	do	5	5	50, 000				do	do	Do.
15	do	do	Perch	2	2	50, 000				do	do	Killed by fungus.
16	do	do	Herring	7	6	600, 000				do	do	Killed by cold water.
17	do	Freestone Point	do	25	26	2, 500, 000				do	do	Do.
17	do	do	Shad	1	1	20, 000	Apr. 26	20, 000	Quantico Creek	do	do	
17	do	Budd's Ferry	Herring	5	8	1, 400, 000				do	do	Killed by cold water.
17	do	Stump Neck	do	12	9	1, 200, 000				do	do	Do.
17	do	do	Perch	2	2	100, 000				do	do	Do.
17	do	do	Herring	10	12	1, 700, 000				do	High water	Do.
18	do	do	do	3	3	900, 000				do	Low water	Do.
18	do	Freestone Point	do	2	2	200, 000				do	do	Do.
18	do	Budd's Ferry	do	2	3	300, 000				do	do	Do.
18	do	Freestone Point	Shad	1	1	30, 000				do	do	Kept for experiment.
18	do	Stump Neck	Herring	12	10	1, 000, 000				do	High water	Do.
18	do	do	Perch	4	3	100, 000				do	do	Do.
19	do	Budd's Ferry	Herring	5	5	2, 100, 000				do	Low water	Do.
19	do	do	Perch	1	1	40, 000				do	do	Do.
19	do	Freestone Point	Shad	1	1	30, 000	May 3	30, 000	Potomac River	do	do	
20	do	Stump Neck	Perch	4	3	150, 000				do	do	Killed by cold water.
20	do	do	Herring	2	2	450, 000				do	do	Do.
20	do	Budd's Ferry	Perch	2	1	100, 000				do	do	Do.
20	do	Clifton	Shad	1	1	20, 000	May 4	20, 000	Potomac River	do	High water	

21	do	Stump Neck	Perch	1	2	50,000				do	Low water.	Killed by cold water.
21	do	do	Herring	14	14	1,600,000				do	do	Do.
21	do	Budd's Ferry	do	15	13	1,800,000				do	do	Do.
22	do	Freestone Point	Perch	1	1	50,000				do	High water.	Do.
23	do	Stump Neck	Herring	15	15	1,600,000				do	Low water.	Do.
24	do	do	do	15	10	2,500,000				do	High water.	Do.
24	do	Budd's Ferry	do	8	9	850,000				do	do	Do.
24	do	Freestone Point	Shad	4	1	15,000	May 7	15,000	Quantico Creek	do	do	
25	do	Stump Neck	Herring	6	6	750,000				do	do	Killed by cold water.
25	do	Budd's Ferry	do	6	6	750,000				do	do	Do.
25	do	Clifton Point	do	9	8	1,100,000				do	do	No fish hatched.
25	do	Stump Neck	do	5	5	700,000				do	do	Killed by cold water.
25	do	Budd's Ferry	do	7	8	700,000				do	do	Do.
25	do	Stump Neck	do	25	26	2,200,000				do	Low water.	Do.
25	do	Budd's Ferry	do	5	5	400,000				do	do	Do.
26	do	do	do	16	16	1,400,000	May 7	800,000	Quantico Creek	do	High water	
26	do	do	do	8	8	700,000		500,000	do	do	Low water.	
26	do	Stump Neck	do	15	16	1,500,000		800,000	do	do	do	
26	do	do	do	5	5	700,000		500,000	do	do	do	
26	do	Budd's Ferry	do	2	2	200,000		100,000	do	do	do	
26	do	Freestone Point	Shad	1	1	25,000	May 7	25,000	do	do	do	
26	do	Clifton Point	Perch	1	2	25,000						No fish hatched.
27	do	Stump Neck	Herring	7	7	500,000	May 3	100,000	Quantico Creek	Muddy	Low water.	
27	do	Budd's Ferry	do	8	8	700,000	May 3	200,000	do	do	do	
27	do	do	do	20	19	1,200,000	May 3	500,000	do	do	do	
27	do	Stump Neck	do	13	11	1,200,000	May 3	500,000	do	do	do	
27	do	do	Perch	2	6	400,000				do	do	No fish hatched.
28	do	Budd's Ferry	Herring	25	23	1,800,000				do	do	Do.
28	do	Stump Neck	do	15	10	750,000				do	do	Do.
28	do	do	Perch	3	2	75,000				do	do	Died in cones.
28	do	do	Herring	10	9	850,000				do	do	Do.
28	do	Budd's Ferry	do	35	30	2,580,000				do	do	Do.
28	do	Stump Neck	do	8	10	1,800,000				do	High water.	Do.
28	do	Freestone Point	Shad	1	1	15,000	May 8	15,000	Quantico Creek	do	do	
29	do	do	do	1	1	15,000	May 8	15,000	do	do	Low water.	
29	do	Budd's Ferry	Herring	17	17	1,550,000	May 6	500,000	do	do	do	
29	do	Stump Neck	Perch	2	2	50,000				do	do	
29	do	Freestone Point	Shad	4	3	147,000	May 8	147,000	Quantico Creek	do	do	
29	do	Stump Neck	Herring	8	6	700,000	May 6	100,000	do	do	do	
30	do	Budd's Ferry	do	15	15	1,200,000				do	do	
30	do	Stump Neck	Perch	6	6	300,000	May 4	150,000	Quantico Creek	do	do	
30	do	Freestone Point	Shad	4	6	175,000	May 9	115,000	do	do	do	
30	do	do	do	11	8	280,000	May 9	255,000	do	do	do	
30	do	Budd's Ferry	Herring	15	15	1,300,000	May 5	950,000	do	do	do	
May 1	do	Stump Neck	do	4	3	425,000	May 6	100,000	do	do	High water.	
1	do	Budd's Ferry	do	21	21	2,123,000	May 6	800,000	do	do	Low water.	
1	do	Stump Neck	do	15	12	1,123,000	May 6	500,000	do	do	do	
1	do	Freestone Point	Shad	5	3	50,000	May 9	45,000	do	do	High water.	
1	do	do	do	15	15	400,000	May 11	390,000	do	do	do	
1	do	Budd's Ferry	Herring	21	21	2,125,000	May 5	500,000	do	do	do	
2	do	Freestone Point	Shad	5	5	150,000	May 10	125,000	do	do	do	

Record of fish-hatching, on board the United States Fish Commission Steamer Fish Hawk, season of 1882, *&c.*—Continued.

Date.	Station.	Fishery.	Kind of fish.	Number. Males.	Number. Females.	Number. Eggs taken.	When deposited.	Number deposited.	Where deposited.	State of water.	Tide.	Remarks.
1882. May 2	Quantico Creek, Virginia.	Freestone Point.	Shad	11	11	275,000			Quantico Creek.	Muddy	High water.	600,000 shad and 2,000,000 herring sent to armory and 455,000 shad put in Potomac River on the 11th of May.
3	do	do	do	9	9	125,000				do	do	
3	do	Budd's Ferry	Herring	25	25	1,550,000				do	do	
3	do	Stump Neck	do	6	8	1,350,000				do	Low water	
3	do	Freestone Point.	Shad	6	6	130,000	May 11	455,000	Potomac River	do	do	
4	do	Budd's Ferry	Herring.	6	4	500,000				do	do	
4	do	Freestone Point.	Shad	2	2	50,000				do	do	
4	do	do	do	3	3	70,000				do	do	
5	do	do	do	2	2	40,000				do	do	
5	do	Stump Neck	Perch	2	3	100,000				do	do	Killed.
5	do	do	Herring.	3	4	360,000				do	do	Killed by cold water.
5	do	Freestone Point.	Shad	1	1	35,000				do	do	
6	do	do	do	8	8	255,000	May 12	50,000	Potomac River	do	High water.	200,000 shad sent to boat-house and 50,000 put in Potomac River on the 12th May.
7	do	Budd's Ferry	Herring.	14	15	1,400,000				do		
7	do	Freestone Point.	Shad	1	1	15,000	May 12	13,000	Potomac River	do		
8	do	Budd's Ferry	Herring.	7	6	500,000				do		Killed by cold water.
8	do	Stump Neck	do	11	9	850,000				do		Do.
8	do	Budd's Ferry	do	11	10	1,000,000				do		Do.
9	do	do	do	12	10	1,000,000				do		Do.
14	Navy-yard	Gill-boat from U. S. F. C. st'r Lookout.	Shad	3	3	40,000	May 22	20,000	Potomac River	do		
23	Battery station	Old Bay Float	do	11	11	336,000				do		
23	do	Gridiron	do	7	8	170,000				do		
24	do	do	do	6	7	147,000				do		
24	do	Cruther's	do	5	5	154,000				do		
24	do	Red Point	do	6	7	185,000	May 31	300,000	Off battery sta.	do		
25	do	Cruthers	do	10	7	215,000						
26	do	Gridiron	do	3	2	77,000						

1882. May 27	Battery Station	Gridiron	Shad	1	1	35,000						
27	do	do	do	2	3	60,000	June 1	200,000	Off Battery Sta'n			
27	do	do	do	2	1	40,000	2	668,000	do			
29	do	do	do	15	13	364,000						
30	do	do	do	10	8	220,000						
30	do	do	do	3	5	112,000						
30	do	Carpenter's Point	do	2	2	84,000						
30	do	Gill boat	do	6	5	112,000						150,000 shipment. 5th June.
June 2	do	do	do	2	1	40,000						
6	do	Pool	do	1	1	10,000						
6	do	do	do	1	1	25,000						
6	do	Gill boat	do	1	2	40,000	June 9	387,000	Off Battery Sta'n			
8	do	do	do	2	3	100,000						60,000 shipment 13th June.
12	do	Pool	do	1	1	25,000						Trans. Battery Station, 13th June.
	Total			909	871	72,794,000		11,373,000				

Meteorological record on board the United States Fish Commission steamer Fish Hawk, Lieut. Z. L. Tanner, commanding, from April 12 *to June* 14, 1882, *inclusive.*

APRIL 12 TO MAY 10, 1882, QUANTICO CREEK, VIRGINIA. MAY 10 TO 22, WASHINGTON, D. C. MAY 23 TO JUNE 14, HAVRE DE GRACE, MD.

Date.	Barometer.		Temp. air.		Water surf.		Bottom.		In cones.		State of water.	Winds.		Weather.
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.		Direction.	Force.	
1882.														
Apr. 12	30.17	30.03	59	33	54	45	54	45	....	....	Muddy......	W. to N. W.	1–3	Clear.
13	30.14	30.01	76	41	56	49	55½	49	57	51	....do	N'd and W'd.	0–3	Do.
14	30.16	30.05	60	45	53	50	53	50	54	52	....do	N. W. to S. E.	0–3	Cloudy.
15	30.22	30.09	73	49	52½	50½	53	50½	54	52	....do	N. N. E. to W. N. W.	1–3	Rain.
16	30.27	30.12	61	46	53	51	53	51	55	53	....do	N'd and W'd.	0–5	Clear.
17	30.35	30.20	71	45	56	50	55	50	57	52	....do	N'd and W'd.	0–4	Do.
18	30.33	30.05	79	45	57	51	57	51	59	55	....do	N. N. W. to S. E.	0–2	Do.
19	30.00	29.59	68	57	56	54	56	54	58	56	....do	S. S. E. to S. W.	0–3	Cloudy.
20	29.73	29.55	78	60	60	53	59	55	60	57	....do	Variable.	1–5	Rain.
21	30.06	29.75	62	49	59½	54	59½	54	60	56	....do	N. W. to N. N. W.	2–6	Clear.
22	30.18	29.95	71	49	57	52	57	52	59	55	....do	Variable.	0–3	Rain.
23	30.00	29.90	52	42	55	50½	55	50½	57	54	....do	N. E. to W. N. W.	1–6	Do.
24	30.27	30.01	63	39	57	48	57	48	58½	50	....do	N'd and W'd.	1–3	Clear.
25	30.37	30.20	72	44	58	52	59	52	60	53	....do	W. N. W. to S. E.	1–3	Do.
26	30.20	29.85	64	53	56	53	55½	52	58	55½	....do	S'd and E'd.	1–4	Cloudy and rain.
27	30.12	29.87	73	49	60	54	60½	54	58	55	....do	Variable.	1–4	Cloudy.
28	30.17	30.05	73	47	58	55	58	55	61	56	....do	N. N. W. to N. N. E.	1–3	Do.
29	30.16	30.05	72	58	59	55	59	56	62	58	....do	N'd and E'd.	2–3	Rain.
30	30.12	30.00	67	54	60	56	60	57	60	58	....do	N. W.	1–5	Fair.
May 1	30.27	30.10	77	46	58	56	59½	56	61½	58	....do	N. W. to S. W.	1–4	Clear.
2	30.32	30.09	66	54	62	57½	62	57	64	58	....do	N'd and W'd.	1–6	Do.
3	30.49	30.15	70	39	59	55	59½	55	61	58	....do	Variable.	1–3	Do.
4	30.12	29.90	79	54	60½	57	60½	57	62	59	....do	S.	1–3	Cloudy.
5	30.01	29.92	70	59	60	58	60	58	63	60	....do	W. to N. N. E.	1–5	Cloudy and misty.
6	30.25	30.04	60	51	58	56	58	56	60	58	....do	N. N. E.	3–4	Rain.
7	30.49	30.25	62	51	57	51	57	54	58	56	....do	Variable.	1–4	Do.
8	30.45	30.20	69	55	56½	55	56½	55	59	57	....do	N. W. to S. E.	1–2	Cloudy.
9	30.16	29.90	88	59	66	56	66	56	70	58	....do	S. S. W. to S.	0–3	Clear.
10	30.02	29.87	76	64	65	59	63	59	66	62	....do	S. S. W. to S. E.	2–4	Rain.
11	29.94	29.83	63	49	63	57	62	58	65	57	....do	S. E. to N. N. E.	2–7	Do.
12	29.95	29.86	53	49	56	56	56	56	57	56	....do	N. N. E.	3–4	Do.
13	29.93	29.80	55	49	56	53	56	53	57	56	....do	N. N. E.	1–3	Do.
14	29.75	29.65	60	53	54	53	55	53	57	55	Muddy......	Variable.	1–2	Do.
15	30.06	29.70	69	53	54	53	54	53	57	56	....do	W. N. W. to N. E.	1–3	Do.
16	30.20	30.07	64	56	55	54	54	53	57	56	....do	Variable.	0–3	Cloudy.
17	30.30	30.12	79	54	59	54	59	54	62	57	....do	S. W. to N. N. W.	1–4	Do.
18	30.48	30.30	74	51	62	57	62	57	63	59½	....do	N. N. E. to E.	1–4	Do.

	19	30.40	30.25	77	55	62	59	63	58	64	60	....do	S'd and E'd.	1–3	Cloudy.
	20	30.23	30.05	82	57	66	60	64	60	67	62	....do	Variable.	0–3	Clear.
	21	30.14	30.01	83	60	65	62	67	62	69	65	....do	Variable.	0–3	Fair.
	22	30.15	30.05	76	68	66	62	66	65	68	68	....do	S'd and W'd.	0–5	Cloudy.
	23	30.25	30.05	75	60	68	60	66	64	66	66	....do	S. W. to N. W.	0–6	Changeable.
	24	30.32	30.16	71	59	67	62	66½	62	69	62	....do	N. W. to S. E.	0–5	Cloudy.
	25	30.19	30.08	64	58	65	62	64	62	66	63½	....do	S. E. to N. E.	2–5	Do.
	26	30.27	30.12	67	52	66	62	65	61	68	62	....do	N. W. to S. S. E.	1–4	Do.
	27	30.15	30.00	70	54	64	62	63	60½	66	62	....do	S. S. E. to W.	1–3	Do.
	28	30.00	29.79	76	66	66	62	65	61½	68	64	....do	S. S. E. to S. W.	0–7	Do.
	29	30.10	29.77	69	60	65	64	64	63	67	66	....do	N. W. to N. E.	1–6	Clear.
	30	30.22	30.04	75	57	66½	64	66½	63	68	64	....do	N. to S. S. W.	0–5	Do.
	31	30.05	29.82	77	65	69½	65	68½	64½	71	67	....do	S. W.	3–6	Do.
June	1	29.96	29.65	76	60	68	65	68½	65	70	67	....do	S. W. to N. W.	1–8	Do.
	2	30.15	29.96	70	58	68	65	67	65	69	67	....do	N. W. to S. S. W.	0–5	Do.
	3	30.07	29.87	75	60	67	65	67	65	71	65	....do	S. to S. W.	3–4	Do.
	4	29.95	29.85	74	65	68	67	68	67	70	69	....do	S'd and W'd.	3–5	Do.
	5	30.00	29.90	71	60	67	65	67	65	69	66	....do	N'd and W'd.	3–6	Do.
	6	30.12	30.00	74	57	66	63	66	63	68	65	....do	N'd and W'd.	2–5	Do
	7	30.17	30.01	80	61	66	63	66	63	72	65	....do	W.	1–5	Do.
	8	30.10	29.95	83	66	68	65	68	65	74	67	....do	S'd and W'd.	1–5	Do.
	9	30.03	29.91	86	66	70	67	70	67	74	68	....do	N'd and E'd.	1–8	Do.
	10	30.00	29.93	82	68	69	68	69	67	74	70	....do	N'd and E'd.	1–4	Cloudy and rain.
	11	30.17	29.92	76	66	71	68	71	67	76	71	....do	N'd and E'd.	0–5	Fair.
	12	30.37	30.18	80	62	80	69	74	68	74	70	....do	S. W. to S. E.	0–4	Cloudy.
	13	30.39	30.26	82	63	75	67	75	68	73	70	....do	S. W. to S. E.	1–3	Clear.
	14	30.34	30.06	81	64	73	70	73	71	....	....	....do	....	....	

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ABBREVIATIONS FOR KIND OF BOTTOMS.—M. for mud; S. for sand; G. for gravel; Sh. for shells; P. for white; rd. for red; yl. for yellow; gy. for gray; bu. for blue; dk. for dark; lt. for light; gn. for green; small; rky. for rocky.

Date.	Thermometer used.	Number of observations.	Locality.	Hour.	Tide.	Tempera Air.	Surface.	5 fathoms.
1882. Feb. 27	N. Z. 46402 for surface and bottom, Signal service.	1050	Chesapeake Bay, Point No Point, N. N. E. 1′½.	2.00 p. m.	Ebb ..	50	41	....
27	....	1051	Chesapeake Bay, Point No Point, N. by E. 1′.	2.15 p. m.	..do ...	50	41	....
27	....	1052	Chesapeake Bay, Point No Point, N. N. E. ¾′.	2.30 p. m.	..do ...	50	41	....
27	....	1053	Chesapeake Bay, Point No Point, N. by E. 1′¼.	2.45 p. m.	..do ...	50	41	....
27	Ther. for air......	1054	Chesapeake Bay, Point No Point, N. by E. 1′¼.	2.50 p. m.	..do ...	50	41	....
28	... do	1055	Patuxent River, Drum Point, N. E.′½	10.40 a. m.	Flood .	46	40	....
28	... do	1056	Patuxent River, Drum Point, N. N. E. ⅓′.	10.55 a. m.	..do ...	46	40	....
28	....do	1057	Chesapeake Bay, south end Barren Island, E. by S. 1′¾.	12.00 m.	..do ...	49	40	....
28	....do	1058	Chesapeake Bay, south end Barren Island, S. E. by E. ½ E. 2′.	12.10 p. m.	..do ...	49	40	....
28	....do	1059	Chesapeake Bay, south end Barren Island, S, E. ¼ E. 2′.	12.30 p. m.	..do ...	49	40	....
28	....do	1060	Chesapeake Bay, Smith's Point, S. S. W. 2′	4.20 p. m.	..do ...	46	41½	....
Mch. 2	....do	1061	Chesapeake Bay, Smith's Point Light-house, S. by W. ½ W. 1′½.	11.20 a. m.	Ebb ..	48	41½	....
2	....do	1062	Chesapeake Bay, Smith's Point Light-house, S. W. ½ S. 1′¼.	11.40 a. m.	..do ...	48	41½	....
2	....do	1063	Chesapeake Bay, South Point, Tangier Island, N. by E. ¾ E. 2′¼.	1.35 p. m.	Flood .	50	44	....
2	....do	1064	Chesapeake Bay, South Point, Tangier Island, N. N. W. 1′.	2.17 p. m.	..do ...	50	42	....
6	....do	1065	Chesapeake Bay, Cherrystone Light-house, E. by N. 2′.	9.00 a. m.	..do ...	56	45	....
6	....do	1066	Chesapeake Bay, Cherrystone Light-house, E. by S. 3′.	9.20 a. m.	..do ...	56	45	....
6	....do	1067	Chesapeake Bay, Cherrystone Light-house, S. E. by E. ¼ E. 3′.	9.40 a. m.	..do ...	56	45	....
11	....do	1068	Kent Island, Thomas Point Light-house, W. S. W. ¼ W. 2′.	9.50 a. m.	Ebb ..	49	42	...
11	....do	1069	Kent Island, Thomas Point Light-house, S. W. by W. ¾ W. 2′¼.	10.20 a. m.	..do ...	51	42	....
11	....do	1070	Kent Island, Thomas Point Light-house, W. by S. 2′.	10,45 a. m.	..do ...	45	42	....
11	....do	1071	Kent Island, Thomas Point Light-house, W. N. W. ½ W. 2′¼.	11.22 a. m.	..do ...	49	42	....
11	....do	1072	Kent Island, Thomas Point Light-house, N. W. 2′¼.	12.00 m.	..do ...	50	42	...
11	....do	1073	Kent Island, Thomas Point Light-house, N. W. by N. 2′½	12.25 p. m.	..do ...	50	42	....
11	....do	1074	Kent Island, Thomas Point Light-house, N. by W. ½ W. 4′¾.	1.10 p. m.	..do ...	51	43	....
13	N. Z. 47, 995	1075	Sandy Point Light-house, N. by W. ¼ W. 3′½.	9.45 a. m.	Flood .	45	43	....
13	....do	1076	Sandy Point Light-house, N. by W. ¼ W.	10.15 a. m.	..do ...	45	43	....
13	....do	1077	Sandy Point Light-house, N. W. ¼ W. 2′¼.	10.55 a. m.	..do ...	49	43	....
Aug. 2	N. Z. 47996 surface	1078	Cape Cod, Nauset beacons, N. W. ½ N. 10′.	7.30 a. m.	....	72	63	56
2	N. Z. 47995, bottom and intermediate.	1079	Cape Cod, Nauset beacons, N. W. by W. ½ W. 8′¼.	8.40 a. m.	....	69	63½	56½
2	....do	1080	Cape Cod, Nauset beacons, N. W. by W. ½ W. 6′½.	9.40 a. m.	....	69	61½	56
2	....do	1081	Cape Cod, Nauset beacons, W. by S. 5′½.	10.50 a. m.	....	69	59	....
2	....do	1082	Cape Cod Light-house, N. W. ¾ N. 11′½	11.45 a. m.	....	70	59	....

Commission steamer Fish Hawk, season of 1882.

pebbles; Sp. for specks; C. for clay; St. for stone; R. for rock; Oy. oysters; bk. for black; wh. for
br. for brown; hrd. for hard; sft. for soft; fne. for fine; crs. for coarse; brk. for broken; sml. for

ture of air and water.						Depth in fathoms.	Kind of bottom.	Wind.	Drift.	What used.	Specific gravities.			
10 fathoms.	20 fathoms.	30 fathoms.	50 fathoms.	100 fathoms.	Bottom.						Temperature.	Fathoms.	Specific gravity.	Corrected to standard of 60°.
...	...	...	...	...	...	3½	Bn. M., Sh., G.	S. E. 1.	...	O. D	...	...	...	...
...	...	...	...	...	40	2	Bn. M., grass.	S. E. 1.	...	O. D	...	...	...	...
...	...	...	...	...	40	1¾	...do	S. E. 1.	...	O. D	...	...	...	...
...	...	...	...	...	40	2¾	Bn. M., Sh., Oy.	S. E. 1.	...	O. D	...	...	...	...
...	...	...	...	...	40	2¾	...do	S. E. 1.	...	O. D	...	...	...	...
...	...	...	...	...	...	6	Br. M., Sh.	Calm.	...	D	...	...	...	...
...	...	...	...	...	...	6	...do	Calm.	...	R. D	...	...	...	...
...	...	...	...	...	40	17–20	Bn. M	N. 1.	W. N. W. ½′.	T	...	...	...	...
...	...	...	...	...	40	3–25	...do	N. 1.	W. N. W. ¾′.	T	...	...	...	...
...	...	...	...	...	40	2¾–25	...do	Calm.	W. N. W. ¾′.	T	...	...	...	...
...	...	...	...	...	40½	7	Bn. M., Sh	N. E. 2.	S. E. by S. ¾′.	T	...	...	...	...
...	...	...	...	...	41½	11–16	...do	N. W. 2.	S. ½′.	D	...	...	...	...
...	...	...	...	...	41½	16–9½	...do	N. W. 2.	S. by W. 1′.	T	...	...	...	...
...	...	...	...	...	42	10	...do	N. 2.	N. E. by E. ½′.	R. D	...	...	...	...
...	...	...	...	...	42	20–9½	...do	N. W. 2.	N. E. by E. ½′.	R. D	...	...	...	...
...	...	...	...	...	46½	25–12	S	S. S. W. 3.	...	T	...	...	...	...
...	...	...	...	...	45	12–25½	...do	S. S. W. 3.	...	T	...	...	...	...
...	...	...	...	...	47	12–20	...do	S. S. W. 3.	...	T	...	...	...	...
...	...	...	...	...	41	14–9	Bk. M	N. W. 4.	...	T	...	...	...	...
...	...	...	...	...	40	18	...do	N. W. 6.	...	T	...	...	...	...
...	...	...	...	...	42	15–10	...do	N. W. 6.	...	T	...	...	...	...
...	...	...	...	...	40	14–13	...do	N. W. 6.	...	T	...	...	...	...
...	...	...	...	...	42	16	...do	N. W. 5.	...	R. D	...	...	...	...
...	...	...	...	...	42	13	Bk. M., Sh	N. W. 3.	...	R. D	...	...	...	...
...	...	...	...	...	41	18–11	Bk. M	N. W. 3.	...	T	...	...	...	...
...	...	...	...	...	40	14–11	M	N.N.W.5.	...	T	...	...	...	...
...	...	...	...	...	40	15	...do	N.N.W.5.	...	T	...	...	...	...
...	...	...	...	...	40	11–12	...do	N.N.W.5.	...	T	...	...	...	1.0040
40	...	...	...	...	37	55	Gn. M., fne S.	W. S.W. 3	S. by W. ½′.	T	...	...	...	...
44	...	...	...	...	37	62	Fne S	W. S.W. 3	E. S. E. 1′.	T	...	...	...	...
45	...	...	...	...	37	55	...do	W. S.W. 2	W. N. W. 1′.	T	...	...	...	...
40	...	...	...	...	39	34	Crs. G. and P.	W. S.W. 2	N. W. by N. 1′.	T	...	...	...	...
...	...	...	...	...	40	28	Crs. G	W. S.W. 1	N. W. by N. ½′.	T	...	...	...	...

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Date.	Thermometer used.	Number of observations.	Locality.	Hour.	Tide.	Tempera Air.	Surf.	5 fathoms.
1882. Aug. 2	N. Z. 47995, bottom and intermediate.	1083	Cape Cod Light-house, W. by N. 15′.	12.45 p. m.	....	77	64	59
2	....do	1084	Cape Cod Light-house, W. N.W. ⅜ W. 8′.	2.20 p. m.	.. ....	78	63	....
3	....do	1085	Cape Cod Race Point Light-house, S. 33° E. 2′.	6.15 a. m.	....	67	64	61
3	....do	1086	Cape Cod Race Point Light-house, S. 20° W. 2′¾.	7.00 a. m.	....	74	64	....
3	....do	1087	Cape Cod Light-house, S. S. W. 7′...	8.30 a m.	....	84	63	46
3	....do	1088	Cape Cod Light-house, S. W. ¾ W. 9′½	9.50 a. m.	....	83	62	59½
3	....do	1089	Cape Cod Light-house, S. W. ¾ W. 14′	11.10 a. m.	....	78	63	....
3	....do	1090	Cape Cod Light-house, S. W. ¼ W. 13′¾.	11.50 a. m.	....	81	62	56
			OFF MARTHA'S VINEYARD.					
11	N. Z. 47996, surface.	1091	Lat. 40° 03′ N., Long. 69° 44′ W......	5.30 a. m.	....	77	75	....
11	N. Z. 47995, bottom and 5 and 10 fathoms.	1092	Lat. 39° 58′ N., Long. 69° 42′ W......	6.54 a. m.	....	79	75	....
11	....do	1093	Lat. 39° 56′ N., Long. 69° 45′ W......	8.35 a. m.	....	82	75	....
11	{ *N. Z. 47992 .... / †N. Z. 47998 .... }	1094	Lat. 39° 57′ N., Long. 69° 47′ W......	10.10 a. m.	....	84	76	....
11	....do	1095	Lat. 39° 55′ 28″ N., Long. 69° 47′ W..	11.55 a. m.	....	82	76	75½
11	....do	1096	Lat. 39° 53′ N., Long. 69° 47′ W......	1.39 p. m.	....	78	75½	75½
11	....do	1097	Lat. 39° 54′ N., Long. 69° 44′ W......	3.10 p. m.	....	76	75½	....
11	....do	1098	Lat. 39° 53′ N., Long. 69° 43′ W......	4.35 p. m.	....	78	75	72
			VINEYARD SOUND.					
18	....do	1099	Nobska Point Light-house, W. S. W. ¼ W. 1′⅝.	11.06 a. m.	Flood.	76	72	....
18	....do	1100	Nobska Point Light-house, W. S.W. ¼ W. 1′¼.	11.47 a. m.	..do ...	77	72	....
18	... do	1101	Nobska Point Light-house, W. by S. 1′¼.	12.15 p. m.	..do ...	78	72	....
18	....do	1102	East Chop Light-house, N. W. ¾ W. 2′½.	1.10 p. m.	Slack.	73	70	....
18	....do	1103	East Chop Light-house, N. W. by W. 2′¾.	1.42 p. m.	..do ...	70	70	....
18	....do	1104	East Chop Light-house, W. N. W. ½ W. 4′.	2.12 p. m.	..do ...	79	70	....
18	N.Z. 47996, surface.	1105	Cape Poge Light-house, S. by W. 4′.	3.00 p. m.	Slack.	80	72	....
18	N. Z. 47995, bottom and 5 and 10 fathoms.	1106	Cape Poge Light-house, S. by W. ½ W. 5′ ½.	3.35 p. m.	Ebb...	80	72½	....
			OFF MARTHA'S VINEYARD.					
22	{ N. Z. 47992 / N. Z. 47998 }	1107	Lat. 40° 02′ N., Long. 70° 35′ W.....	6.00 a. m.	....	69½	71	71½

Commission steamer Fish Hawk, season of 1882.—Continued.

[Tempera]ture of air and water.						Depth in fathoms.	Kind of bottom.	Wind.	Drift.	What used.	Specific gravities.			
10 fathoms.	20 fathoms.	30 fathoms.	50 fathoms.	100 fathoms.	Bottom.						Temperature.	Fathoms.	Specific gravity.	Corrected to standard of 60°.
42	....	....	....	....	38	84	Not taken.	W. S. W. 1	W. S. W. ½′.	T.....	....	......	......	......
44	....	....	....	....	38	38	Crs. G	W. S. W. 2	W. S. W. 1′.	T.....	....	......	......	......
43	....	....	....	....	39	35	Gn. M., fne S.	W. S. W. 3	S. by E. 1′.	T.....	....	......	......	......
44	....	....	....	....	39½	34	Fne S.....	W. S. W. 3	S. ¾′.	T.....	....	......	......	......
41	....	....	....	....	39	44	Gy. S......	N. W. 2.	W. S. W. ½′.	T.....	....	......	......	......
...	....	....	....	....	38	90	Crs. S.....	N. W. 3.	N. W. 1′½.	T.....	....	......	......	......
...	....	....	....	....	38½	110	Gy. M.....	W. S. W. 1	N. W. by W. ½′.	T.....	....	......	......	......
52	....	....	....	....	38½	110	....do	W. S. W. 1	W. S. W. ¾′,	T.....	....	......	......	......
62	....	....	....	....	46	65	Gy. S. and crs. Sh.	N. W. 3.	N. W. by W. ½′.	T.....	....	......	......	......
...	....	....	....	....	41	202	Gy. S	N. W. 3.	N. N. W. ¾′.	T.....	....	......	......	......
...	....	....	....	....	40	349	S. and bu. M.	N. W. 3.	N. N. W. 1′.	T.....	....	......	......	......
...	†51	*44	....	....	40	301	Bu M.....	N. W. 2.	N. W. by N. 1′.	D.S.T.	....	......	......	......
72	49	†47	*45	....	40	321	Sft. gn. M .	N. W. 2.	N. N. W. ½ W. ¾′	D.S.T.	....	......	......	......
65	....	....	....	....	40	317	....do	W. N. W. 3	N. W. ½ N. ½′.	T.....	....	......	......	......
..	....	....	....	....	45	158	Fne. S.....	W. N. W. 3	N. ½ W. ½′.	T.....	....	......	......	......
60	..	....	....	....	43½	156	....do	W. N. W. 3	N. by E. ¾′.	T.....	....	......	......	......
...	....	....	....	....	71½	6	S. and G...	N. 2.	N. E. by N. ½′.	T.....	....	......	......	......
...	....	....	....	....	71½	4¾	S., G., and Sh.	N. 2.	N. E. by N. ½′.	T.....	....	......	......	......
...	....	....	....	....	71	5	Sh	N. 1.	N. E. 1′.	T.....	....	......	......	......
...	....	....	....	....	69	5	Crs. S.....	E. 2.	E. by S. ½′.	T.....	....	......	......	......
...	....	....	....	....	69	5	....do	N. E. 2.	E. by S. ¼′.	T.....	....	......	......	......
...	....	....	....	....	69	8½	Sh	E. N. E. 3.	N. W. by W. ¾ W. ½′.	T.....	...	......	......	......
...	....	....	....	....	71	10	Gy. S......	N. E. 3.	N. E. by E. ½ E. 2′	T.....	....	......	......	......
...	....	....	....	....	72	5	S. and Sh .	N. E. 3.	N. E. by N. ¼′.	T.....	....	......	......	......
66	....	....	....	....	48	116	Gy. M.....	W. S. W. 2	N. W. 1′.	T.....	....	......	......	......

Dredging and trawling record of the United States Fish

Date.	Thermometer used.	Number of observations.	Locality.	Hour.	Tide.	Tempera		
						Air.	Surface.	5 fathoms.
1882. Aug. 22	....do	1108	Lat. 40° 02′ N., Long. 70° 37′ 30″ W.	6.55 a. m.	....	69½	71	....
22	....do	1109	Lat. 40° 03′ N., Long. 70° 38′ W.	7.55 a. m.	....	70½	71	....
22	....do	1110	Lat. 40° 02′ N., Long. 70° 35′ W.	9.16 a. m.	....	75	72	....
22	Surf. thermometer, N. Z. 46402.	1111	Lat. 40° 01′ 33″ N., Long. 70° 35′ W.	10.45 a. m.	....	76	72	....
22	....do	1112	Lat. 39° 56′ N., Long. 70° 35′ W.	12.43 p. m.	....	72	72	72
22	....do	1113	Lat. 39° 57′ N., Long. 70° 37′ W.	1.45 p. m.	....	75	72	71½
22	N. Z. 47998	1114	Lat. 39° 58′ N., Long. 70° 38′ W.	2.40 p. m.	....	74	72	71½
22	....do	1115	Lat. 39° 59′ N., Long. 70° 41′ W.	3.28 p. m.	....	75	72½	72
22	....do	1116	Lat. 39° 59′ N., Long. 70° 44′ W.	4.20 p. m.	....	77	72	72
22	....do	1117	Lat. 40° 02′ N., Long. 70° 45′ W.	5.30 p. m.	....	78	72	72
22	....do	1118	Lat. 40° 03′ N., Long. 70° 45′ W.	6.20 p. m.	....	74	72	....
			OFF NANTUCKET.					
26	N. Z. surf, 46402, bottom 5 and 10 fathoms.	1119	Lat. 40° 08′ N., Long. 68° 45′ W.	6.32 a. m.	....	68	65	65
26	N. Z. No. 47995	1120	Lat. 40° 05′ N., Long. 68° 48′ W.	7.41 a. m.	....	69	65	65
26	....do	1121	Lat. 40° 04′ N., Long. 68° 49′ W.	9.05 a. m.	....	65	65	64
26	....do	1122	Lat. 40° 02′ N., Long. 68° 50′ W.	10.28 a. m.	....	70	67	66
26	....do	1123	Lat. 39° 59′ 45″ N., Long 68° 54′ W.	12 m	....	70	69	....
26	....do	1124	Lat. 40° 01′ N., Long. 68° 54′ W.	4.01 p. m.	....	65	65	....
26	....do	1125	Lat. 40° 03′ N., Long. 68° 56′ W.	5.45 p. m.	....	65	64	....
			VINEYARD SOUND.					
28	....do	1126	Gay Head Light-house, W. S. W. 2′¾	1.46 p. m.	H′f ebb	72	66	....
28	....do	1127	Gay Head Light-house, W. by S. 3′	2.30 p. m.	Ebb	69	66	....
28	....do	1128	Gay Head Light-house, W. ¾ S. 2′¾	3.10 p. m.	..do	69	66	....
			OFF NO MAN'S LAND.					
Sept. 2	....do	1129	Fishing Village, S. ¼′	2.00 p. m.	....	72	65	....
2	....do	1130	Fishing Village, S. ½ E. ⅛′	2.13 p. m.	....	72	65	....
2	....do	1131	Fishing Village, S. E. by E. ½′	2.29 p. m.	....	72	65	....

Commissson steamer Fish Hawk, season of 1882—Continued.

ture of air and water.											Specific gravities.			
10 fathoms.	20 fathoms.	30 fathoms.	50 fathoms.	100 fathoms.	Bottom.	Depth in fathoms.	Kind of bottom.	Wind.	Drift.	What used.	Temperature.	Fathoms.	Specific gravity.	Corrected to standard of 60°.
...	...	...	...	...	48	101	Gy. M. fne S.	W.S.W.2.	N.W. $\frac{3}{4}'$.	T ...	...	...	...	...
...	...	...	...	...	49	89	Gy. S ...	N. 2.	N. N. W. 1'.	T ...	...	...	...	...
...	...	...	...	...	47	100	Gn. M. fne S.	N. 2.	N. by W. $\frac{1}{2}$W. 1'	T ...	...	...	...	...
...	...	...	...	...	47	124	Fne S ...	N. E. 2.	N. N. E. $\frac{1}{2}$ E. 1'.	D.S.T.	...	...	...	...
65	49	...	...	...	43	245	S. and Gn. M.	N. E. 2.	N. W. by N. 1'.	D.S.T.	...	...	...	...
65$\frac{1}{2}$	49	46	...	...	43	192	Gn M ...	N. E. 2.	N. 1'.	D.S.T.	...	...	...	...
65	...	...	43 49	...	45	171	Gn M ...	N. E. 2.	N. by W. 1'.	D.S.T.	...	...	...	...
70	...	...	...	...	45	146	S. and gn M	N. E. 2.	W. by N. $\frac{3}{4}'$.	D ...	...	...	...	...
68	...	...	...	...	46	144	Hd S. gn M	S. E. 2.	N. W. by W. 1'.	D ...	...	...	...	...
62	...	...	...	...	48	89	Fne S ...	N. 3.	N. by E. 1'.	D ...	...	...	...	...
...	...	...	...	...	49	70	Fne S ...	N. 2.	N. N. W. $\frac{1}{4}'$.	D ...	...	...	...	...
...	...	...	...	...	48	97	S. and brk. Sh.	N.N.E.3.	N. E. $\frac{1}{2}$ N$\frac{3}{4}'$.	T ...	...	...	...	...
56	...	...	...	...	43$\frac{1}{2}$	194	Fne S. and St.	N.N.E.3.	N. W. 1$\frac{1}{2}'$.	T ...	...	...	...	...
56	...	...	...	...	41$\frac{1}{2}$	234	Fne S. and St.	N.N.E.4.	W. N. W. 1'.	T ...	...	...	...	...
60	...	...	...	...	40$\frac{1}{2}$	351	S. and St	N.N.E.4.	N. W. 1'.	T ...	...	...	...	...
...	...	...	...	...	39	787	S. and gn M	N.N.E.4.	N. N. W. 1'.	D.S.T.	...	...	...	...
...	...	...	...	...	39	640	Fne S. and gn. M.	N.N.E.4.	N. W. by N. 1'.	D.S.T.	...	...	...	...
...	...	...	...	...	40	291	S. and M ..	N.N.E.4.	N. W. by N. 1'.	D.S.T.	...	...	...	...
...	...	...	...	...	63$\frac{1}{2}$	14	S. and blk M.	S. S. E. 3.	S. E. by E. $\frac{3}{4}'$.	T ...	...	...	...	...
...	...	...	...	...	64	10	Gy S ...	S. S. E. 4.	E. S. E. $\frac{1}{2}'$.	T ...	...	...	...	...
...	...	...	...	...	65	9	M. and gy S.	S. S. E. 4.	S. by E. $\frac{1}{4}'$.	D ...	...	...	...	...
...	...	...	...	...	62	4	S. and St..	E.N.E. 4.	N. E. by E. $\frac{1}{4}'$.	D ...	...	...	...	...
...	...	...	...	...	62	4	S. and St..	E.N.E. 4.	N. W. by N. $\frac{1}{8}'$.	D ...	...	...	...	...
...	...	...	...	...	63	4$\frac{1}{2}$	S ...	E.N.E. 4.	E. by N. $\frac{1}{4}'$.	D ...	...	...	...	...

Dredging and trawling record of the United States Fish

Date.	Thermometer used.	Number of observations.	Locality.	Hour.	Tide.	Tempera- Air.	Surface.	5 fathoms.
			OFF NO MAN'S LAND.					
1882. Sept. 2	N. Z. 46402 surf. bottom 5 and 10 fathoms.	1132	Fishing Village, S. E. by E. ¼′	2.45 p. m.	....	72	65	....
2	N. Z. No. 47995....	1133	Fishing Village, S. E. ¾′	3.10 p. m.	....	72	65	....
			MENEMSHA BIGHT, VINEYARD SOUND.					
6	....do	1134	Gay Head Light-house, W.S.W. ¾ W. 2¾′	1.26 p. m.	Ebb...	76	66	....
6	....do	1135	Gay Head Light-house, W. ½ S. 3′	2.20 p. m.	Slack..	71	66	....
6	....do	1136	Gay Head Light-house, W. S. W. ¾ W. 3′	3.50 p. m.	Flood.	70	66	....
			OFF BLOCK ISLAND.					
8	....do	1137	Lat. 39° 40′ N., Long. 71° 52′ W.	6.00 a. m.	....	68	70	69
8	....do	1138	Lat. 39° 39′ N., Long. 71° 54′ W.	7.24 a. m.	....	72	71	70
8	*N. Z. 47993 †N. Z. 47992 ‡N. Z. 47996	1139	Lat. 39° 37′ N., Long. 71° 55′ W.	8.48 a. m.	....	74	72	70
8	....do	1140	Lat. 39° 34′ N., Long. 71° 56′ W.	10.35 a. m.	....	78	73	72
8	....do	1141	Lat. 39° 32′ N., Long. 71° 57′ W.	12.27 p. m.	....	80	74	73
8	....do	1142	Lat. 39° 32′ N., Long. 72° W.	0.52 p. m.	....	80	74	74
8	....do	1143	Lat. 39° 29′ N., Long. 72° 01′ W.	3.36 p. m.	....	80	74	73
8	....do	1144	Lat. 39° 33′ N., Long. 72° 06′ W.	6.00 p. m.	....	75	74	73
			OFF MARTHA'S VINEYARD.					
Oct. 4	N. Z. surf., 46402 bottom 5, 10, and 20 fathoms.	1150	Lat. 39° 58′ N., Long. 70° 37′ W.	6.35 a. m.	....	65	62	62
4	N. Z. No. 47,998 No. 25 F. 47993	1151	Lat. 39° 58′ 30″ N., Long. 70° 37′ W.	7.45 a. m.	....	66	62	62
4	45 F. No. 47992 95 F. No. 47995	1152	Lat. 39° 58′ N., Long. 70° 35′ W.	8.42 a. m.	....	68	62	62
4	....do	1153	Lat. 39° 54′ N., Long. 70° 37′ W.	10.45 a. m.	....	70	62½	62
4	....do	1154	Lat. 39° 55′ 31″ N., Obs. Long. 70° 39′ W.	12.10 p. m.	....	72	62½	....
4	....do	1155	Lat. 39° 52′ N., Long. 70° 30′ W.	4 06 p. m.	....	64	63	62

Commission steamer Fish Hawk, season of 1882—Continued.

ture of air and water.						Depth in fathoms.	Kind of bottom.	Wind.	Drift.	What used.	Specific gravities.			
10 fathoms.	20 fathoms.	30 fathoms.	50 fathoms.	100 fathoms.	Bottom.						Temperature.	Fathoms.	Specific gravity.	Corrected to standard of 60°.
...	....	....	....	....	62	4	S. St	E. N. E. 4.	N. N. E. ½′.	D	....	......	......	......
...	....	....	....	....	62	4	....do	E. N. E. 4.	E. by S. ¾′.	D	....	......	......	......
...	....	....	....	....	64	9½	S. and M. .	N. E. 4.	N. W. by N. ½′.	T......	....	......	......	......
...	....	....	....	....	64	7½	....do	N. E. 4.	N. E. ¼′.	T......	....	......	......	......
...	....	....	....	....	63	10	M.	N. E. 3.	N. E. ¼′.	D	....	......	......	......
62½	....	...	....	....	46	176	Fne. S.....	Calm.	N. N. W. ½′.	T......	....	......	......	......
...	....	....	....	....	46	168	S..........	....do ...	N. W. 1′.	D.S.T.	....	......	......	......
64	....	47*	49†	48½‡	44	291	M.........	N. W. 1.	N.W. by W. 1′⅓.	D.S.T.	....	......	......	......
68	....	53	49	49	40	374	S. sft M. G	N. W. 2.	N. 1′.	D.S.T.	....	......	......	......
70	....	59	53	51	40	389	S. and M. .	N. W. 2.	W. by N. ½ N. 1′	D.S.T.	....	......	......	......
72	....	71	48	50	41	322	M.........	N. W. 1.	W. by S. ½′.	D.S.T.	....	......	......	......
73	....	55	49	50½	40	452	....do	W. 1.	N. W. 2.	D.S.T.	....	......	......	......
72	....	60	50	50	41	386	Sft M.	W.S.W.1.	N. 1.	D.S.T.	....	......	......	......
61	....	....	....	....	47	140	S..........	W.N.W.2	E. ½′.	T	....	......	......	......
62	....	..	....	....	48	125	....do	W.N.W.2	E. 2′.	T......	....	......	......	......
62	....	45	44½	....	48	115	....do	W.N.W.3	E. 1′½.	T......	....	......	......	......
61	....	52	44	45	44	225	S. and gn M.......	W.N.W.3	N. ½ W. 1′½.	T......	....	......	......	......
...	....	48	46	60	....	193	....do	N. W. 3.	N. by W. 1′½.	T......	....	......	......	......
61	48½	47	54	48	40	554	....do	N. W. 3.	N. N. W. ½′.	D.S.T.	....	......	......	......

Table of distances made under steam by the United States Fish Commission steamer Fish Hawk, for the year 1882.

Date.		Where bound.	Daily distance.	Distance between ports.
1882.			*Miles.*	*Miles.*
Feb.	25	From Washington to Cornfield Harbor	88	88. 00
	27	From Cornfield Harbor to Saint Jerome's Creek	28	28. 00
	28	Dredging trip	44	44. 00
Mar.	1	Shifting berth	6	6. 00
	2	Dredging trip	40	40. 00
	3	Cod Harbor to Cherrystone Inlet	51	51. 00
	5	Setting nets	23	23. 00
	6	Dredging trip	126	126. 00
	7	Shifting anchorage	3	3. 00
	11	Dredging trip	25	25. 00
	13	......do	26	26. 00
	21	......do	14	14. 00
	22	Annapolis to Washington	78	....
	23	......do	79	157. 00
	30	Navy-yard to Emery's coal wharf and return	4	4. 00
Apr.	10	Washington to Quantico	28	28. 00
May	10	Quantico to Washington	28	28. 00
	22	Washington to Havre de Grace, Md.	113	....
	23	......do	72	185. 00
June	10	Havre de Grace to Baltimore and return	53	....
	11	......do	27	80. 00
	14	Shifted berth	5	5. 00
	15	Havre de Grace to Washington	124	....
	16	......do	70	194. 00
	19	Washington to Annapolis by way of Saint Jerome's Creek	70	....
	20	......do	21	....
	21	......do	68	159. 00
	22	Annapolis to Saint Jerome's Creek	57	57. 00
	24	Saint Jerome's Creek to Point Lookout and return; Saint Jerome's to Annapolis Roads	71	71. 00
	25	Annapolis Roads to Annapolis Harbor	3	3. 00
	26	Annapolis to Point Lookout, thence to Saint Jerome's	71	71. 00
	28	Steamed out to make compass observations	6	6. 00
	29	Steamed out to make compass observations and from Saint Jerome's to Washington	36	....
	30	From Saint Jerome's to Washington	66	102. 00
July	8	Washington to Wilmington, Del.	150	....
	9	......do	181	....
	10	do	25	356. 00
	11	Wilmington, Del., to Havre de Grace, Md.	121	....
	12	Wilmington, Del., to Saint Jerome's Creek	186	....
	13	......do	61	368. 00
	14	Saint Jerome's to Baltimore and return	86	86. 00
	15	Saint Jerome's to Washington, D. C	60	....
	16	......do	51	111. 00
	21	Washington to Wood's Holl, Mass	99	....
	22	......do	225	....
	23	......do	223	....
	24	......do	1	548. 00
Aug.	1	Dredging trip	34	....
	2	......do	65	....
	3	......do	99	198. 00
	10	......do	66	....
	11	......do	99	....
	12	......do	59	224. 00
	14	Wood's Holl to New Bedford	14	14. 00
	15	New Bedford to Wood's Holl	14	14. 00
	18	Dredging trip	35	35. 00
	21	......do	47	....
	22	......do	114	....
	23	......do	45	206. 00
	25	......do	81	....
	26	......do	103	....
	27	......do	90	274. 00
	28	......do	25	25. 00
Sept.	2	......do	38	38. 00
	6	......do	25	25. 00
	7	......do	70	....
	8	......do	125	....
	9	......do	94	289. 00
	11	Wood's Holl to New Bedford	14	14. 00
	13	New Bedford to Wood's Holl	14	14. 00
	28	Shifted berth	$\frac{1}{4}$	. 25
	29	......do	$\frac{1}{4}$	. 25
	30	......do	$\frac{1}{4}$	. 25
Oct.	3	Dredging trip	49	....
	4	......do	125	....

Table of distances made under steam by the United States Fish Commission steamer Fish Hawk, for the year 1882—Continued.

Date.	Where bound.	Daily distance.	Distance between ports.
1882.		*Miles.*	*Miles.*
Oct. 5	Dredging trip	48	222.00
12	Wood's Holl to Bristol, R. I	65	65.00
17	Bristol to Newport, R. I	8	....
18	......do	4	12.00
19	Newport to New York	92	....
20	......do	54	146.00
21	New York to Wilmington, Del	17	....
22	......do	13	....
23	......do	1	....
24	......do	64	....
25	......do	136	231.00
27	Wilmington, Del., to Washington, D. C	103	....
28	......do	201	....
29	......do	50	351.00
	Total	....	5,493 75

SYNOPSIS OF THE STEAM LOG FOR THE YEAR ENDING DECEMBER 31, 1882.

Stroke of piston, in feet	$2\frac{1}{4}$
Number of condensing cylinders	2
Diameter of condensing cylinders, in inches	22
Mean point of steam cut-off from commencement of stroke of piston, in inches	6.75
Mean number of holes of throttle-valve open	6.4
Mean vacuum in condenser, in inches of mercury	24.8
Mean steam pressure in boilers while engines were in operation	22.5
Mean temperature of engine room	93
Mean temperature on deck	67
Mean temperature of injection water	62
Mean temperature of discharge water	96
Mean temperature of feed water	82
Total time fires were lighted, in hours and minutes	4,543.20
Total time fires were lighted for hatching, in hours and minutes	1,487.40
Total time engines were in operation, in hours and minutes	785.44
Total time engines were in operation for dredging, in hours and minutes	123
Total number of revolutions of starboard engine	3,640,730
Total number of revolutions of port engine	3,505,090
Mean number of revolutions per minute *en route*	88.61
Mean piston speed, in feet per minute	409.5
Total number of knots run	5,493.75
Mean number of knots per hour	6.8
Mean number of knots per hour *en route*	8.6
Total weight of coal consumed for engineer's department	$471\frac{1956}{2240}$
Total weight of coal consumed while engines were in operation	$238\frac{534}{2240}$
Total weight of coal consumed for galley	$24\frac{580}{2240}$
Total weight of coal refuse	$97\frac{1590}{2240}$
Mean number of pounds of coal consumed per hour while engines were in operation	667
Total number of gallons of oil consumed	371
Total number of pounds of tallow consumed	112
Total number of pounds of wiping stuff	221
Mean draft forward, in feet and inches	7.9
Mean draft aft, in feet and inches	7.6

Number of screws	2
Kind of screws	True.
Mean pitch of screw, in feet and inches	12.3
Diameter of screw, in feet and inches	6.8
Length of screw, in inches, parallel to axis	20
Number of blades on each screw	4
Maximum indicated horse-power	277
Mean indicated horse-power	252.7
Mean number of pounds of coal per horse-power	2.21
Maximum number of pounds of coal per square foot of grate	13.9
Mean number of pounds of coal per square foot of grate	12.8
Maximum speed attained under steam alone in knots per hour	10
Number of hours maintained	5.30
Slip of screw at maximum speed, in per cent	12
State of tide and sea	Smooth.
Mean slip of screw, in per cent. *en route*	19.57

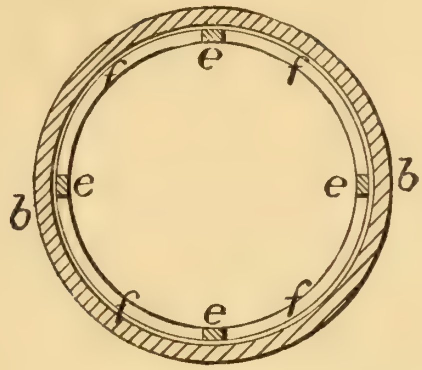


Fig. 2.

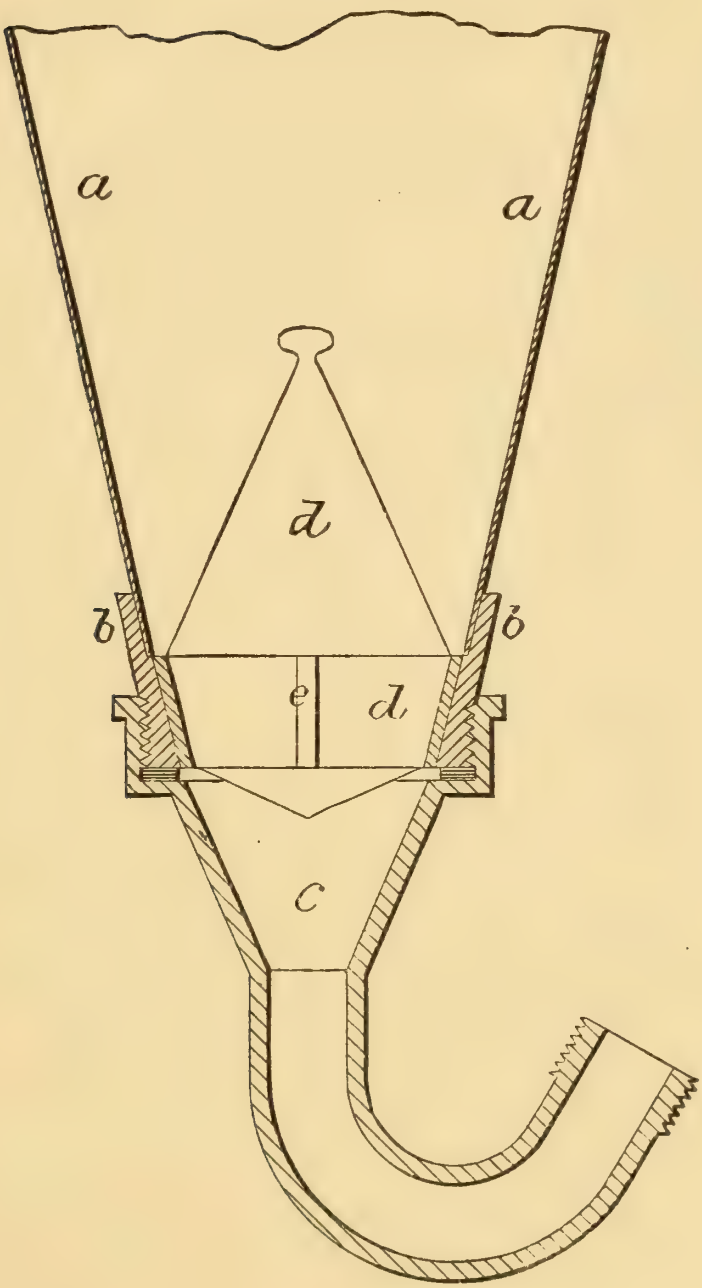


Fig. 1.

Shad-hatching cone.

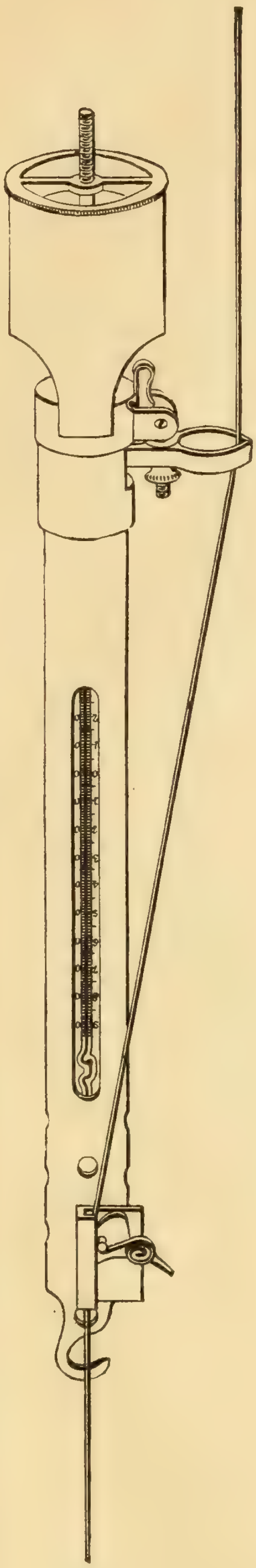


Fig. 1.

Fig. 2.

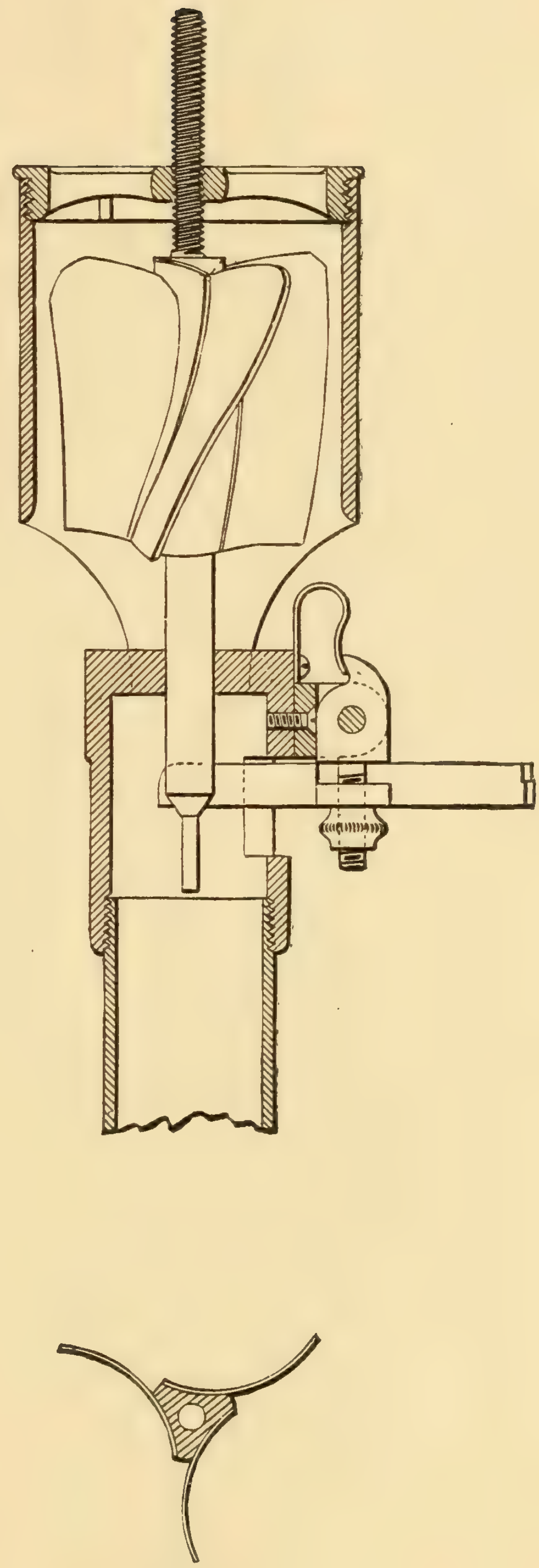
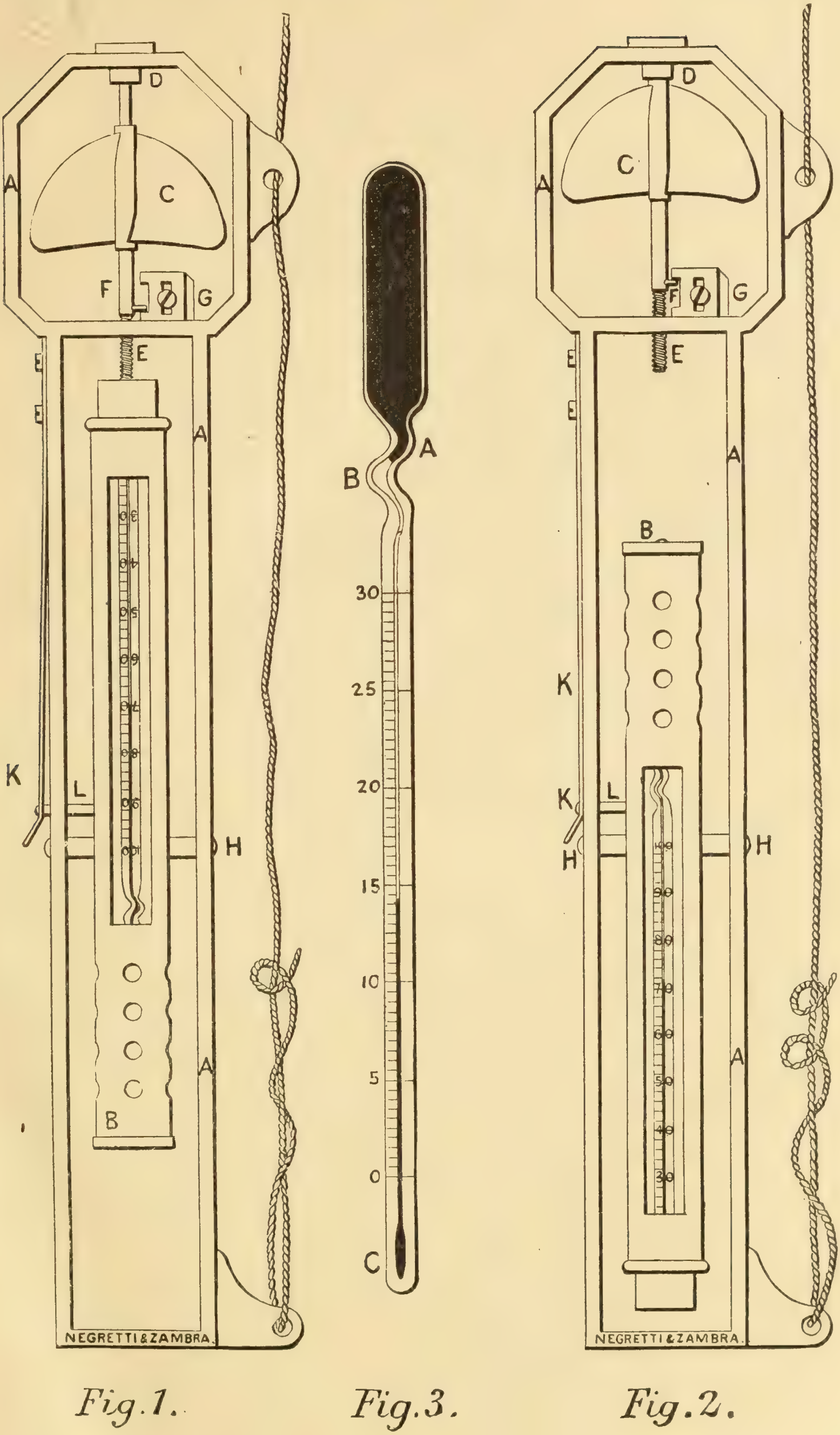


Fig. 3.

The Bailie-Tanner deep-sea thermometer case.



The Negretti-Zambra deep-sea thermometer.

INDEX.

NOTE.—The references are to page-figures in brackets.

II.—REPORT OF THE OPERATIONS OF THE UNITED STATES FISH COMMISSION STEAMER LOOKOUT FROM MARCH 31, 1881, TO NOVEMBER 20, 1882.

By Lieut. W. M. Wood, U. S. N.

The following is a report of the operations of the United States Fish Commission steamer Lookout while under my command.

On the 31st of March, 1881, I relieved Mate James W. Baxter, the vessel then lying in Baltimore Harbor:

Left Baltimore on the 6th of April with a large scow in tow loaded with lumber and arrived with it at Saint Jerome's Creek on the afternoon of the 7th. The next day we proceeded up the Potomac to Washington, where we lay refitting until April 20.

On the 20th got under way for a cruise to the hatching grounds in Albemarle Sound and intermediate points.

We left Albemarle Sound on April 26 and reached Washington again on the 30th, having touched at Fisherman's Inlet, Virginia, Saint Jerome's Creek, Maryland, and several of the Potomac fishing shores on the way up.

On the 3d of May commenced making daily trips to the fishing shores collecting eggs and carrying them to the hatching-house at the Washington navy-yard. The work was interrupted on the 8th to make a trip to Saint Jerome's. Returning to Washington on the 10th resumed the collection of shad eggs. On the 22d took from the hatching station at Gunson's Cove about 1,000,000 shad fry, carried them across the Chesapeake and deposited them in the headwaters of the Choptank River. Arrived back at Washington on the 24th and continued the shad work until the 31st. Then commenced refitting and overhauling preparatory to a cruise on the New England coast.

Left Washington on the 22d of June, touched at Saint Jerome's, Mob Jack Bay, Cherrystone Inlet, Fortress Monroe, Norfolk, Va., and left the Bay bound north on the 29th. Arrived in Newport on the 3d of July, touching at New York and New London on the way. Then cruised on the New England coast until the beginning of October, going as far north as New Brunswick.

We left Newport October 4 for Baltimore, touching at Wilmington, Del., and Havre de Grace. We left Baltimore on the 17th of October for Yorktown, Va., returning to Baltimore on the 21st.

Sailed for Saint Jerome's on the 25th and arrived in Washington on

the 28th. We left again on the 11th of November, bound for Havre de Grace, with a scow and other stores for the fishing battery on board; arrived there on the 13th, and remained until the 26th, the crew being employed in various ways at the Battery Island.

On the 26th loaded with lumber for Saint Jerome's, waited for orders three days in Annapolis on the way down, arrived November 30 at Saint Jerome's, and December 1 in Washington.

We left again for Saint Jerome's on the 6th, dredged oysters for several days, and then proceeded to Havre de Grace, arriving there on the 11th of December. On the 13th went to Annapolis, Md., and on the receipt of a number of carp carried them up the Severn River and let them go near Indian Landing.

Left Annapolis on the 19th, arriving at Washington on the 21st, having touched at Saint Jerome's on the way round.

Remained at the Washington yard, overhauling and preparing hatching outfit for the coming season, until March 4, when we left for Saint Jerome's and Havre de Grace, arriving at the latter place on the 7th. On the 11th we ran down to Baltimore, returning on the 14th. On the 15th started for Annapolis with a delegation of citizens of Port Deposit and Havre de Grace, landing them at Annapolis that evening.

Remained at Annapolis until the 23d, when we started for Washington, arriving on the 24th. Remained until April 2. On that day made a run down as far as Potomac Creek to see what shores were fishing and with what success.

Returned to Washington on the 3d, and left again same day, with launch No. 55 in tow, for Havre de Grace, arriving on the 5th; remained until the 11th, with the crew employed on shore; then proceeded to Washington, touching at Baltimore and Saint Jerome's on the way.

On the 18th of April, 1882, commenced the spring shad work on the upper Potomac, the hatching-house at the navy-yard having also been placed under my control, with Masters W. C. Babcock and A. C. Baker as assistants.

This work was carried on until the 1st of June, the Lookout making daily trips to the fishing shores and bringing the eggs to the hatching-house to be hatched. A detailed report of all this work has already been submitted.

On the 3d of June the vessel went onto the marine railway at the navy-yard for repairs, and was launched again on the 12th. On the 15th it left for a cruise on the lower Chesapeake, touching at Saint Jerome's, Fort Monroe, Norfolk, Newport News, and returning to Washington on the 23d, where we remained until the 8th of July, when we again ran down to Saint Jerome's, returning on the 11th.

On the 17th left Washington at 10.11 a. m., bound for New York, and arrived there at 6.20 a. m. of the 19th, making no stops en route.

Left New York on the 21st of July, and arrived at Block Island on the 23d, having touched at New London on the way. The remain-

ing portion of the summer cruised on the New England coast; left Newport, R. I., bound south, September 30, arriving in Baltimore October 6, having been delayed several days in New York by break in the canal.

Left Baltimore October 31 for Havre de Grace, arriving there the same day; returned to Baltimore again on the 7th of November, and after coaling proceeded to Washington, touching at Annapolis, and arriving on the 9th.

Got under way on the 15th for Havre de Grace, touching at Saint Jerome's, and arriving on the 16th. On the 20th of November, 1882, I turned the vessel over to Chief Quartermaster William Hamlen and proceeded to Washington to take command of the Fish Hawk.

III.—DESCRIPTION OF THE UNITED STATES FISH COMMISSION CAR NO. 2, DESIGNED FOR THE DISTRIBUTION OF YOUNG FISH.

By Frank S. Eastman.

This car was built for the transportation of young fish from the hatching stations of the United States Commission of Fish and Fisheries to the several sections of the country to which it is desirable to transport young fish for the purpose of propagation. It is of the F. S. Eastman patent, adapted by the patentee to the special uses of the Commission, and is constructed with sufficient strength and durability to safely transport a load of 20,000 pounds over any road in the country at passenger rate of speed. It also affords comfortable and tasteful accommodations for the officers and employés of the Commission who superintend the distribution of the load.

The material used in construction is of the best quality of its several kind, and put together in the best and strongest manner.

Plates I and II represent the general appearance outside of the car. Having been built at the car-shops of the Baltimore and Ohio Railroad Company the name of their road is by courtesy retained upon the letter-board, but that in no way signifies ownership. It is of the standard passenger car style, with moderate ornamentation. It has two six-wheel standard trucks of 4 feet 8½ inches gauge, each truck complete in all its parts, fitted with springs of unusual strength and standard quality. The brakes are of the Westinghouse air patent, complete in all their details, ready for attachment to any passenger train. The Miller platform has been used, with Janney couplers and continuous draw-bar. The car has extra suspension trusses under the intermediate as well as under each outside sill, springing over body bolsters, and attached to head frames. The doors at the sides are for convenience in handling the cans containing the young fish into and from the middle and refrigerating compartment of the car.

Plate I shows the side opening and the cans in process of handling, with the grating for protecting the side of the car from injury, which is thrown up when the doors are closed.

Plate III shows the interior arrangement of the middle section of the car, with the covers to the refrigerator chambers in place. The seats for passengers are hung up and out of the way to facilitate work among the fish cans. The intermediate sills of the car are spaced to conform to the dimensions of the refrigerator chambers, with diagonal brace and counter-brace, post and panel, trusses constructed upon them; each

brace with counter tension-rod, and each post with continuous tension-rod through plates and sills. These trusses spring from the ice boxes located over the body bolsters of the car, and form the inside walls of the refrigerator chambers. The top cords of the auxiliary trusses are 30 inches above the floor. The spacing of the floor, sides, and roof-framing of the car is of standard dimensions. The carlins and rafters are of the usual size, and the carlins in the vicinity of the ice boxes pass across the car from wall plate to wall plate, with binding rods in the floor and roof structure. The roof is of first-class car pattern, with lights and ventilators spaced and paneled as in a first-class passenger car. The general arrangement and details of the floor, wall, and roof framing is that of a passenger car strengthened for transportation of a load of 20,000 pounds at passenger rate of speed.

There are four ice boxes, two near each end, and over the trucks of the car. The space between the ice boxes forms the passage from the middle to the end compartment of the car, with communicating doors. The ice boxes have corner and intermediate parts framed to sills, plates, and carlins of the car in a most substantial manner. They run from the floor to top of the wall plates of the car, and the exterior of the ice boxes conforms to the finish of that portion of the car in which it is located. The ice boxes on each side of the car are connected by a low, continuous refrigerator chamber as shown in the plate. The top, floor, exterior and interior sides of refrigerator chambers and ice boxes are filled with cork used for non-conducting material. The top of the chambers are fitted with covers which admit of easy access to the interior, in which the cans of fish are placed. The refrigerator chambers are 34 inches wide, 26 inches high, and 34 feet in length, inside measurement. The ice boxes are capable of carrying 3,000 pounds of ice.

The whole interior of ice-boxes and refrigerator chambers are lined with zinc, and admit of being easily drained and cleaned.

The middle section of the car is fitted with four sleeping berths, and forms an attractive and comfortable saloon for the accommodation and comfort of the employés of the Commission accompanying the car, while the young fish are transported in the low refrigerator chambers, cooled by the circulation of the cold air from the ice-boxes, and rendered easy of access by the removal of the covers.

Plate IV represents the covers thrown back, and showing cans in refrigerated space, also showing the method of handling the cans through the side door, and of running them lengthwise of the car on the traveling truck suspended on the bar passing overhead the whole length of the compartment.

Plate V shows the office end of the car, and looking through open doors into the middle section. The manner in which officers and employés accompanying the car are accommodated with meals is shown in this plate, where also the seats for their accommodation are shown in place. The office is fitted with sleeping-berth, wash-room, and closet

for a Baker heater, which supplies heat through pipes running under floor grating to the compartments, without affecting the temperature of the refrigerator chambers in which the fish are transported.

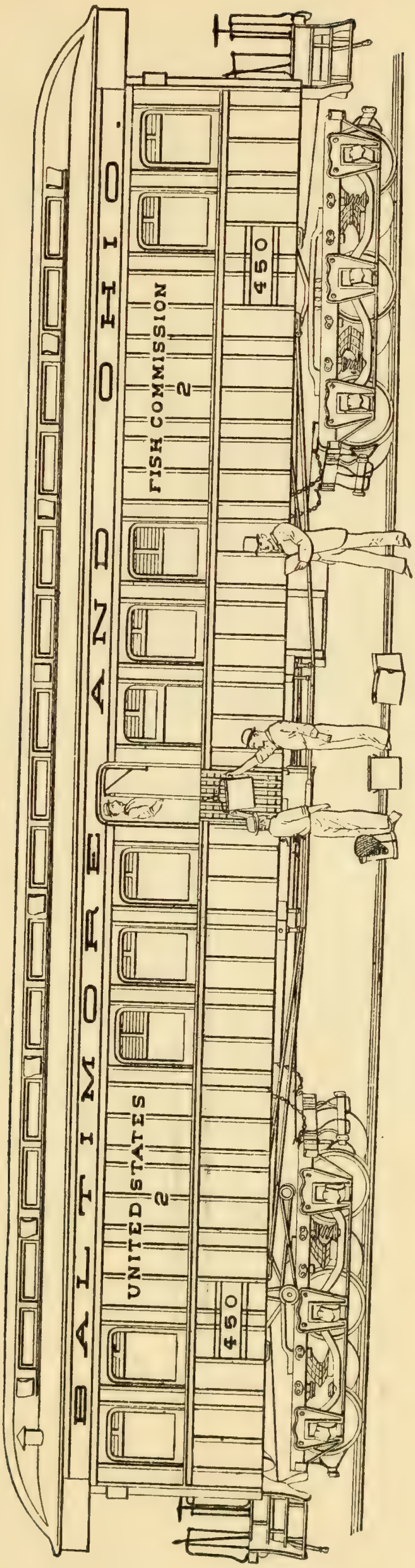
Plate VI represents the sleeping-berths prepared for the occupants, with side doors open for ventilation.

The end of the car opposite the office is furnished as kitchen and pantry. The pantry is desirably shelved and fitted with tray and drawers. The kitchen space around the stove is arranged for the proper stowage of utensils, and the sink has a waste-pipe through the floor of the car.

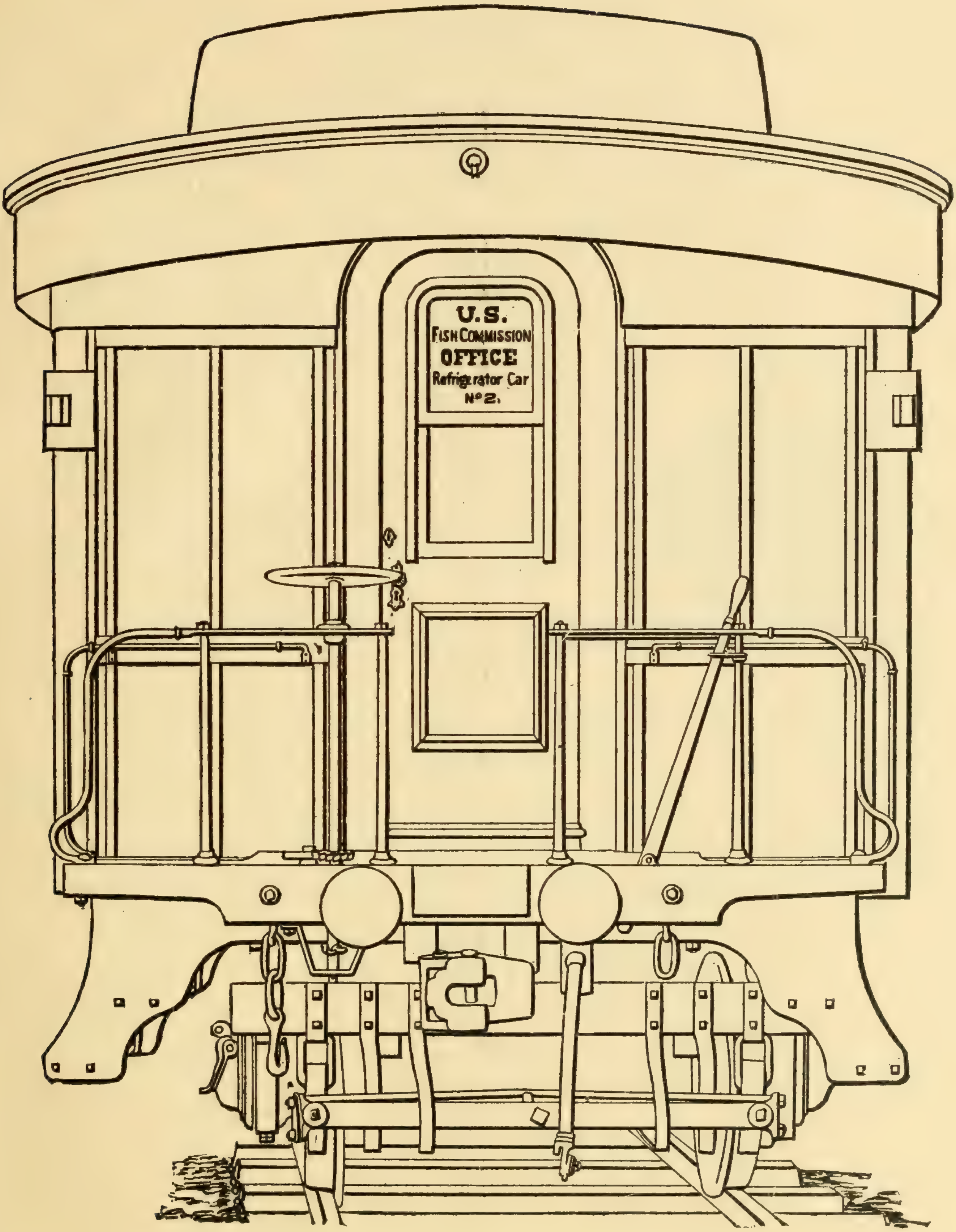
In the same end, on the opposite side of passage, is the pump and blower room. By means of this pump and blower a circulation of water and air is sustained for supply to the young fish in the cans, which are connected by a system of pipes and rubber hose, which permits a perfect circulation through them. Suspended in each ice-box is a galvanized iron tank, separated from the ice by a hinged 3-inch grating, which contains fresh aerated water for supplying the waste through the circulating system. The pump and blower are actuated by means of a friction roller which bears upon the tread of the truck of the car and communicates its motion to the machine-room by means of belts and pulleys.

The load on the car is so distributed as to make it unusually safe and easy running at high rates of speed, and the extra trusses forming the inside walls of the refrigerator chambers give the car superior strength and rigidity.

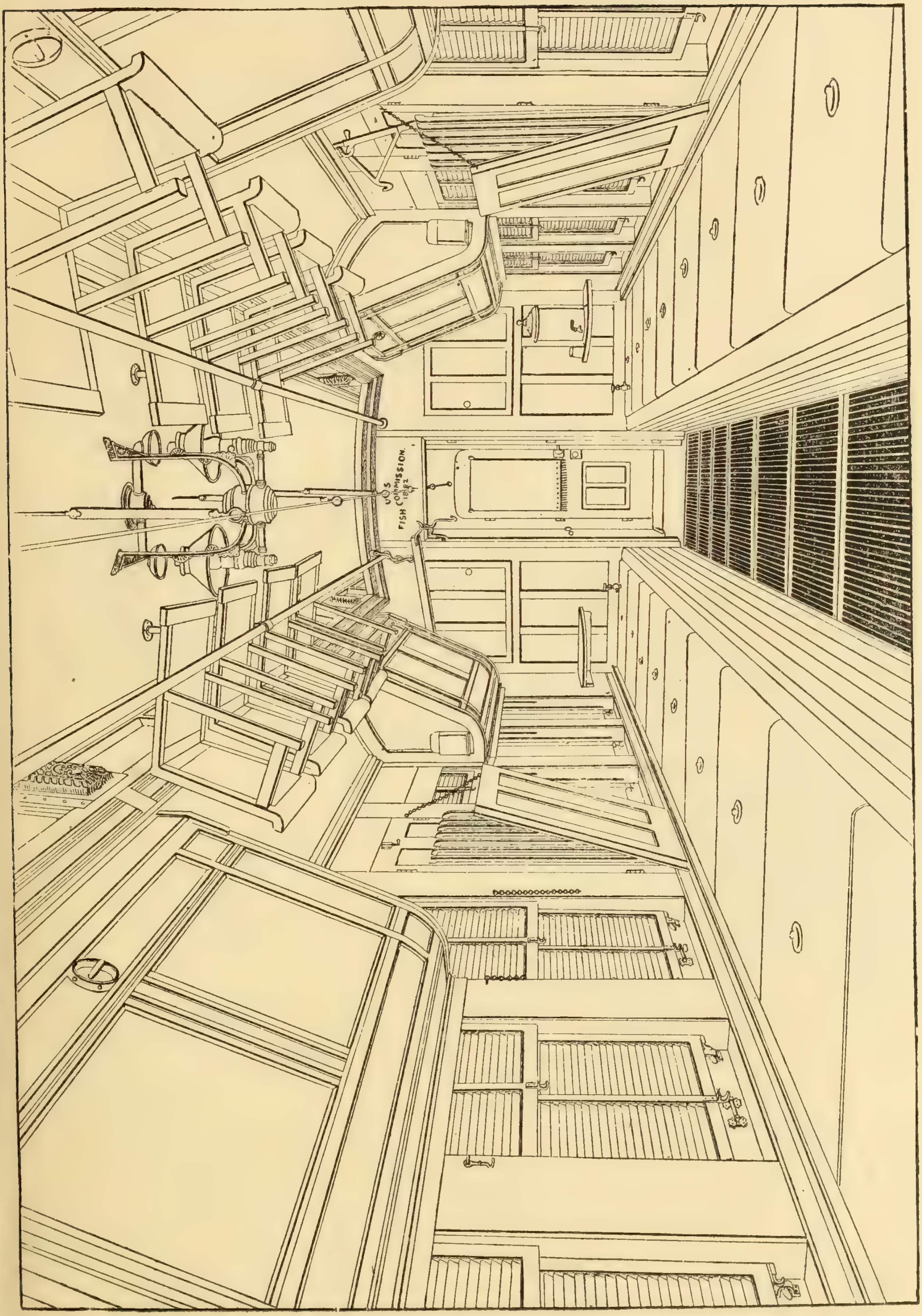
PLATE I.



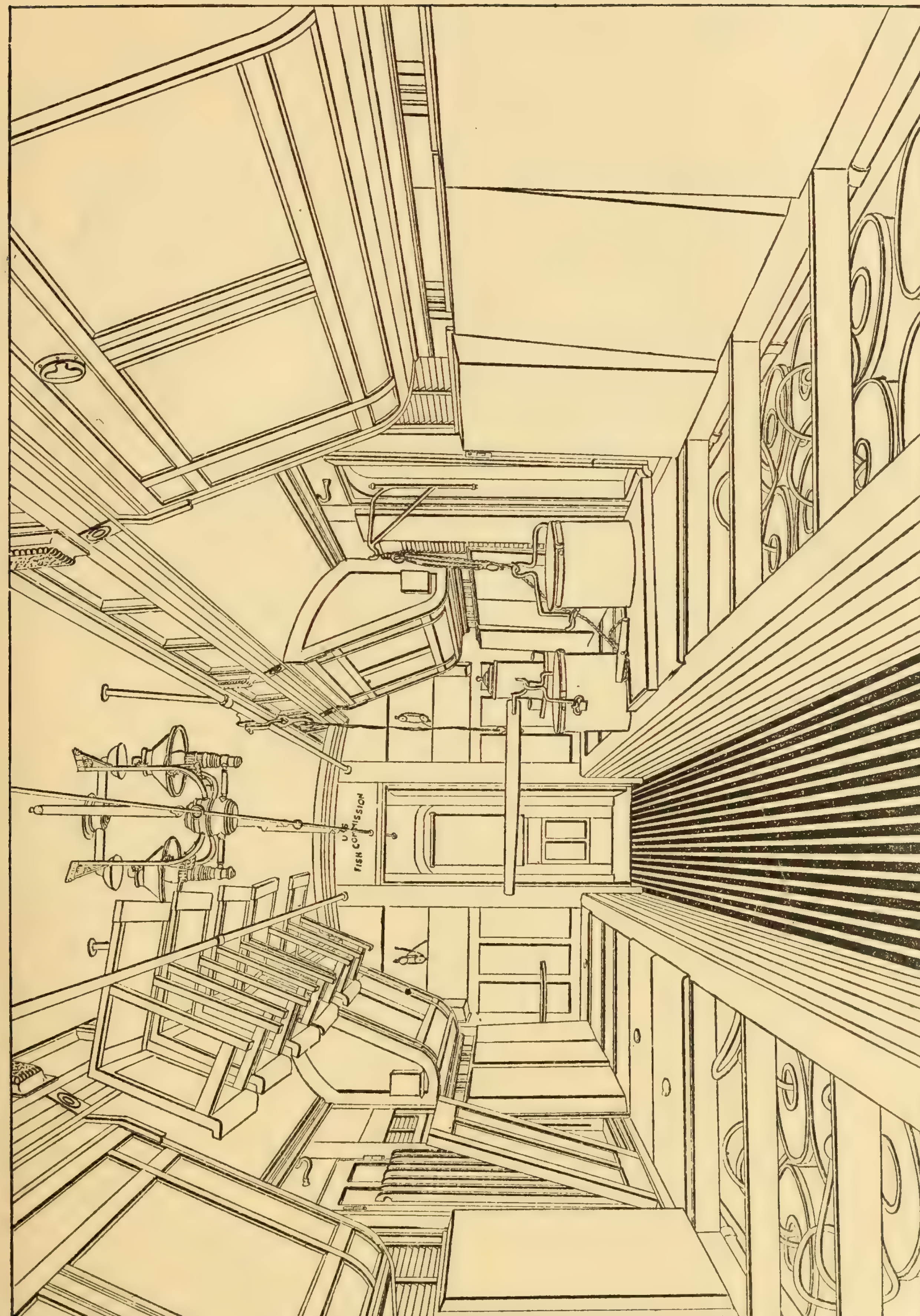
Side view of exterior of Refrigerator car No. 2.



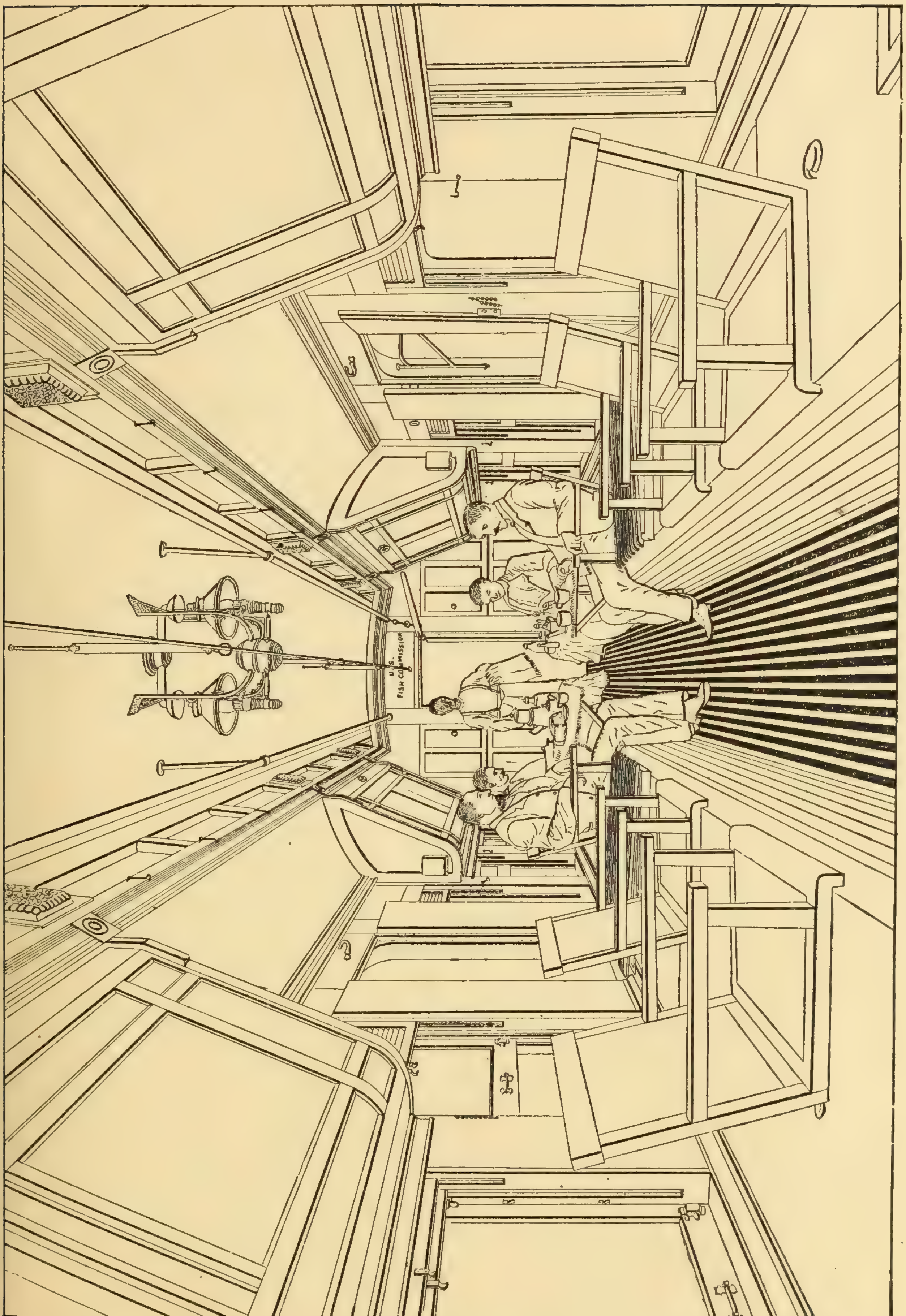
End view of Car No. 2.



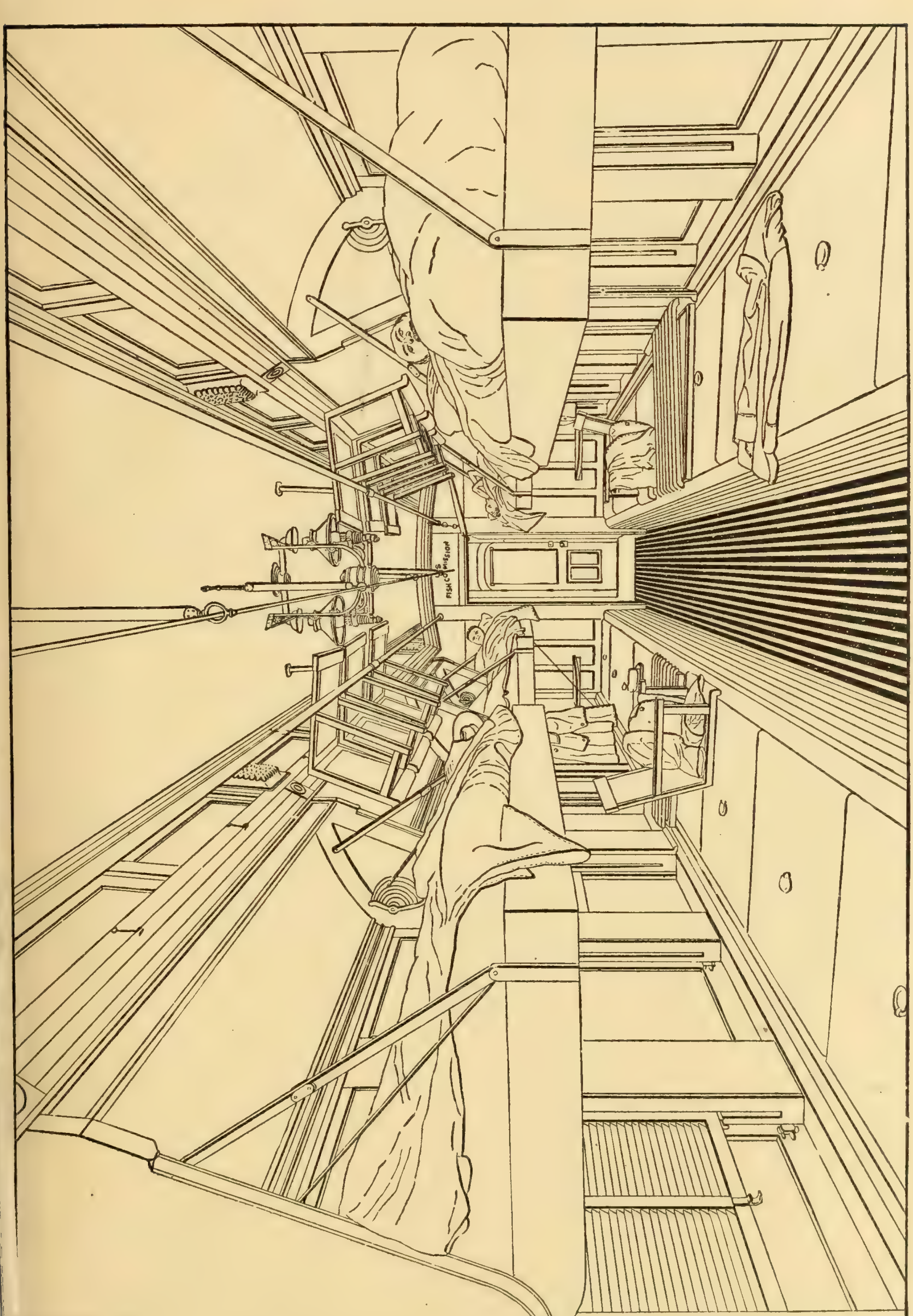
Interior view of car when not in use.



Interior view of car showing arrangement of cans of fish.



Interior view of car showing eating arrangements.



Interior view of car showing sleeping arrangements.

IV.—A NEW SYSTEM OF FISHWAY-BUILDING.

BY MARSHALL MCDONALD.

1. THE OBJECT OF FISHWAYS.

It is a well established fact that the river fisheries of the Atlantic States have steadily decreased both in value and annual production for many years past. In some instances species that were at one time common in certain of our rivers are no longer taken. Indeed, the annual run of those fish which still continue their migration to the rivers has undergone alarming decrease; and in many cases become too insignificant to furnish the motive or material for organized fisheries.

Several causes, probably, have concurred in producing this decrease: (1.) The capture of the greater portion of the run each year may not have left sufficient to maintain production under natural conditions. (2.) The erection of dams or other obstructions in the rivers has, in some cases, absolutely excluded certain species from their spawning grounds; the result being eventually to exterminate the species referred to in those rivers. In all cases the existence of such obstructions has determined a decrease in the natural productiveness of the stream *pro tanto* with the diminution of the breeding and feeding area.

The remedy for the condition of things above indicated is to be found: (1.) In the enactment of such legislation as will control excessive fishing, and prohibit destructive methods. (2.) In compensating for the insufficient natural supply by artificial propagation and planting. (3.) In extending the area for breeding and feeding by overcoming natural obstructions by means of fishways.

If the anadromous fishes only entered our rivers for the purpose of spawning, and their progeny spent no part of their life in our fresh waters, then the increase which we could determine by artificial propagation would be practically without limit. The fish-culturist, in order to maintain the supply, would only have to produce the young fry in numbers sufficient to replace losses by capture or by casualty. As regards all the anadromous species, however, which are the object of commercial fisheries, viz, the salmon family, the shad, the herring or alewife, &c., it is necessary that the young, after hatching, should remain for some time in our fresh waters, feeding and growing, and, of course, finding the necessary food in these waters. The extent of the breeding and feeding area of any river basin is, therefore, necessarily the measure of its possible productiveness. A given area, when pressed to its maximum of production, cannot provide for more than a given number of in-

dividuals. The extension of the area of production is, therefore, the rational means by which we may determine permanent increased productiveness. Hence arises the necessity for fishways, which are, in short, various constructions designed for the purpose of enabling different species of fish to surmount obstructions which would be otherwise impassable to them.

2. The necessary conditions of an efficient fishway and the defects of the old forms.

A fishway, to be effective, must fulfill certain conditions, which are clearly stated by Mr. C. G. Atkins in an admirable article on the subject of fishways, published in the annual report of the United States Fish Commission for 1872–'73, as follows:

"(1). It must be accessible; that is, the foot of the fishway must be so located that fish will readily find it. (2.) It must discharge a sufficient volume of water to attract fish to it. (3.) The water must be discharged with such moderate velocity that fish may easily enter and swim against the current."

To the conditions above stated we may add: (4.) The route to be traveled by the fish should be as short and as direct as possible, and the floor of the fishway should simulate as nearly as may be the bed of the stream.

The first condition may be always fulfilled in the location by arranging so as to have the discharge of water from the fishway in a line with or in the immediate vicinity of the obstruction.

The second condition is more embarrassing. The larger the volume of water discharged through the fishway the better it will be. In the kinds of fishways which are common throughout New England the volume of the discharge is necessarily limited by conditions inherent in the constructions; is compelled to travel a circuitous channel, and usually is delivered from the fishway in such a sluggish current that it offers no sufficient invitation to fish to enter and ascend it. As before stated, the difficulty of a limited capacity for water is inherent in all of these fishway constructions.

The attention of fish-culturists and fishway-builders has been heretofore chiefly directed to different devices for controlling the velocity of the water in the fishway. All these devices may be referred to one of two general forms:

(1.) The "step" or "pool and fall" fishway, in which the water is brought down from its elevation by a series of short drops or falls with intervening pools, the pools being of such dimensions in comparison with the volume of water entering them as to bring it practically to rest after each drop, so that the whole volume of water is eventually delivered from the lower end of the fishway with no greater acceleration than it obtains in falling from one pool to the next. This form of fishway is very common in England and upon the Continent. Possibly

some examples of such constructions may be found in the United States, but I have no information of any.

(2.) The inclined-plane fishway, as it is termed by Mr. Atkins, in which the descent of the water is effected by a regular inclination of the floor of the fishway, instead of by "steps" or "pools and falls." In order to control the tendency to acceleration under the action of gravity the base of the incline is made very long in proportion to the height, and by a series of alternating transverse or oblique partitions the water is constrained to follow a narrow, tortuous path with continual changes of direction, the friction developed in its movement being sufficient to overcome the tendency to acceleration. Of this second general form we have many examples in the United States, especially in New England. The common rectangular fishway, the Brackett, the Foster, Pike's, Atkins', Swazey's, Brewer's, and Rogers' are examples of the various designs that have been employed, each differing in minor details of construction, but all belonging to a common system.

Most of these forms may be built either on an incline leading straight down from the dam or with a return section so as to deliver the discharge from the fishway close up to the foot of the dam, or they may be built in spiral form and boxed over so as to be made secure against floods and ice. The fishway of Mr. J. D. Brewer is peculiar in the fact that the channel to be followed by the fish is a zigzag groove excavated or framed in the floor of the incline, which is built either of masonry or strong timbers; the strength of the construction being such, it is presumed, as to prevent its destruction by floods or ice. The Rogers fishway is recessed into the dam and boxed over, the lower end discharging the water on a line with the face of the dam. This construction could, however, be applied to any of the forms above indicated and has been proposed in several of them.

The experience of fishway builders in New England has shown that for dams 10 feet in height or more it is not allowable to build the incline with a rise of more than 1 foot in from 12 to 16, requiring a length of incline of 140 feet for a 10-foot dam. The actual path, however, traveled by the water and traversed by the fish ascending would be some two or three times the length of the incline, so that fish passing up an inclined-plane fishway rising 10 feet vertically, would necessarily travel a distance of from forty to fifty times the height of the dam. For example, in the fishway over the Hadley Falls dam on the Connecticut River, the total length of the incline is about 450 feet. The distance to be travelled by the fish ascending it is not far short of 1,500 feet, to overcome an ascent of about 29 feet. All the different designs of fishways constructed according to the incline-plane system have, when judiciously located, proved more or less successful in passing certain species of fish. In all, however, the labyrinthine route to be traversed, and the insignificant flow of water through them, constitute very serious objections.

3. An ideal fishway.

If it be possible by any practical construction to deliver the whole volume of a stream over a dam or other obstruction with such moderate velocity that the weakest and least adventurous fish could readily swim against it, we would practically destroy the obstruction, and would establish for the migratory species a passage up to their spawning-grounds as free and unrestrained as if no obstruction existed. In practice, of course, this ideal can be realized only in exceptional cases, for industrial necessities, or considerations of cost, will necessarily limit the dimensions of the fishway and the amount of water that may be discharged through it; but just in proportion as we approximate this ideal in our fishway constructions do we approach more nearly the solution of the problem of free circulation of the anadromous fishes in Continental waters.

When the commission of fisheries was inaugurated in the State of Virginia, in 1875, one of the most important questions presented to it was how to make adequate provision to get the anadromous fish over the innumerable dams that obstruct the main water-courses of the State and all their tributaries. The white shad (*Alosa sapidissima*) is one of the most important food-fishes in all the tributaries of the Chesapeake, and in times past has furnished the motive of immense and profitable fisheries. The restoration and maintenance of this valuable fishery was one of the most serious questions presenting itself to the consideration of the Commission. The James and the Rappahannock Rivers were obstructed at the head of tide by insuperable dams, interposing effectual obstructions to the further upward migration of the anadromous species. Years ago, before obstructions existed, the migration of the shad in James River extended into the heart of the Alleghanies, two hundred and fifty miles above tide-water, and in the Rappahannock to the very base of the Blue Ridge Mountains. The curtailment of the breeding area, by the erection of dams on both rivers, had determined a corresponding reduction in the productive capacity of the streams, and, in concurrence with the irrational and unrestrained methods of fishing pursued, had rendered franchises, once valuable, worthless, and industries, once profitable, precarious and unproductive. A fishway that would freely pass shad up over these obstructions, and recover to production the breeding area of water from which they had been excluded, promised the means of restoring these most valuable fisheries.

The gentlemen who were then commissioners of fisheries for the State of Virginia were pleased to select me to visit the Centennial Exposition at Philadelphia, with instructions to make a careful study of the models of all the forms of fishways there exhibited, with the view of finding one that would be adapted to our purpose. A careful study of all was made, and I was reluctantly forced to the conclusion that none of them fulfilled the necessary conditions of successful operation, and I returned discour-

aged, with the conviction that an efficient shad-way was a thing of the future.

4. The principles of the new fishway, and the details of its arrangement.

The conditions to be satisfied in a successful fishway construction are as follows: (1) The water should be delivered down a straight unobstructed channel. (2) In sufficient volume to invite the entrance of fish. (3) With such moderate velocity as to permit their ready ascent. (4) With a view to economy in construction, it is important that the inclination or slope of the way should be much more considerable than in the ordinary inclined-plane fishway.

How to construct so as to fulfill these conditions was the problem to be solved. Two methods suggested themselves. It was possible to make the water do work in its descent, and thus control velocity. A fishway could be constructed on this principle by an evident modification of the ordinary turbine wheel. And such a fishway could be made to serve both as a passage-way for fish and as a motive power for machinery. This idea, however, was soon abandoned, for the double reason of its complexity and the limitations to its application that would necessarily exist. The second fruitful idea was that if each molecule of water could be compelled to traverse a constrained path, its final direction in any one circuit being against gravity, it could be brought to rest at a lower level—the friction developed in movement having neutralized in part the force of acceleration. The molecule falling from its second position of rest through a similar circuit, and in succession through any number of circuits, would finally reach any defined lower level with no greater velocity than that attained in the first circuit described. Were it practicable to subject every molecule of water passing through a fishway to the constrained movement above indicated, the result would be a descending current, the average velocity of which would not exceed the average velocity of a molecule in passing to consecutive positions of rest under the conditions above stated.

How this idea has been realized in practical constructions will be understood by reference to the following figures and descriptions.

If we take a hemispherical bowl (Fig. 1), and holding a marble at A, upon the edge of the bowl, we release it, it will fall, under the influence of gravity, through A′ to A″, coming to rest at A″, some distance below the edge of the bowl. The vertical distance between the positions A and A″ measures the force of acceleration that has been counteracted by friction by traveling the constrained path A A′ A″. If now we take a number of similar bowls and cut them off to the line A A″, and arrange them as in Fig. 3, and start a marble at D′, it will pass from D′ to C′, reaching C′ with no greater velocity than that acquired in passing from A to A′. If, however, the marble were allowed to roll unobstructed from A to A″, down the incline plane D C (Fig. 2) it will

have acquired a velocity equal to $8\sqrt{DB}$ approximately. We see, then, in this case, how it is possible to deliver a molecule from a given position to a definite lower position without the increase of velocity that would arise if the molecule fell freely under the action of gravity or rolled down a smooth incline. If it be possible to compel every molecule of water descending through a fishway to submit to the conditions above indicated, then the problem how to control the velocity of a descending current would be solved. Now, to apply this to liquids, we arrange a series of bent tubes, shown in Fig. 4. By suitable arrangements we keep the longer branch of the higher tube of the series full of water. The water escaping from each tube will rise against gravity until it comes to rest, then fall into the longer branch of the adjacent tube in the series, and, after passing through the entire series, be finally discharged from the shorter branch of the lowest bent tube with no greater velocity than it acquired in passing through the first member of the series.

Construct a series of these tubes with branches brought close together, cut away obliquely the upper end of the longer branch of each member of the series, so as to permit access of water, pack them side by side in oblique position in an inclined sluice, as shown in Fig. 5, and we have the solution of the problem with which we started. For if we suppose a current of water to be running through the inclined trough or sluiceway, the first effect will be to fill the tubes with water and establish a flow through them; the water entering the longer branch of each tube will escape from the shorter branch with a velocity due to the head or vertical distance between the two ends of the tube. This final direction being obliquely up the slope, each particle of water will describe a path, as is indicated by the curved arrows shown in Fig. 5. The effect will be that we will have an ascending current in the sluice on that side of the sluice where the shorter branches of the tubes are situated. The velocity of this ascending current will become less and less as we pass toward the middle of the sluice, where there will be a line or section of practically eddy water, and beyond a descending current, becoming more rapid as we pass to the further side of the sluice, where we find a current descending with uniform velocity, the maximum limit of which will be the velocity of the water escaping from the shorter branches, provided the supply of water and the capacity of the tubes are properly proportioned.

The illustrations here given present briefly and graphically the principles applied in the McDonald system of fishway building.

5. Adaptability of the system.

The flexibility of the system adapts it to the widest range of conditions occurring in practice. An effective passage may be provided for fish over obstructions, with the supply of water that will flow through a cross section six inches square, or the fishway may be ex-

panded so as to take the entire discharge of a river. Constructed roughly of boards it furnishes at a nominal cost the means of re-establishing in our innumerable trout streams the natural conditions of reproduction. These fishways may be made so light as to be readily portable, so that, in the season when the fish are not running, they may be stored away under shelter and thus protected from decay or destruction by ice or floods. In public parks and trout preserves, where considerations of cost are not controlling, the fishway may be built of iron in ornamental designs, and while serving its essential purpose, made to contribute to the picturesqueness of the landscape. Solidly built of stone and iron, and of dimensions proportioned to the volume of the stream, it may be made strong enough to resist the utmost force of floods and ice, and by furnishing an easy passage for shad, salmon, and other anadromous species of fish, make possible the restoration and maintenance of our valuable river fisheries, in spite of the obstructions which are the inevitable and necessary adjuncts of civilization.

6. Mode of construction.

As an example of construction we have given in Fig. 6*a* the elevation, and in Fig. 6*b* the plan of a double fishway built of timbers. It consists of an inclined sluiceway of boards, the sides and bottom of which are supported by suitable framing. The sluice has in this case an inclination of 1 foot in 3. The upper end is let into the dam so that its upper line is flush with the crest line of the dam. The lower end descends to the water below the dam and is firmly anchored by being secured by bolts either to the rocky bed of the stream or to piles suitably placed, or by other suitable means. Intermediate supports may be provided by trestling, as shown in the figure, by log cribs or by rubble masonry. The inclined flume or sluice thus established furnishes the foundation for the structure of the fishway proper, which is placed within it. Details of construction are given in Figs. 7, 8, and 9, which are on a scale one-quarter inch to the foot.

The substructure having been established, we begin by setting up along the center line of the trough or sluice the bulkheads *i i i*, &c., at intervals of 12 or 15 inches. These are made of planks 1½ inches thick, 2 feet long, and 15 inches wide, which are firmly attached to the flooring of the sluice either by spikes or bolts. Posts *h h*, &c., of 1½ inch stuff, 9 to 12 inches wide, and extending from the floor to the upper edge of the inclined trough, are now set up at similar intervals of 12 to 15 inches and firmly secured to the sides and bottom of the trough. To the posts *h h*, and bulkheads *i i*, the fifteen-inch joists are securely nailed or bolted. The floor *d* (Fig. 8), of 1½-inch plank, is next laid and nailed to the inclined joists, as shown in Figs. 7 and 8. Upon the floor *d* next set up the short return buckets, *m m*, &c. (Figs. 8 and 9), securing the same to the parts *h h* and to the floor by nailing or other suitable means. The cap *e e* (Fig. 8), made of a

single 2-inch plank, is fastened securely to the sides, *b b*, the posts, *h h*, and the return buckets, *m m*, thus completing the construction.

We have here realized in timber the same construction and secured the same control of the descending current as shown in the experimental apparatus (Fig. 5). The course of the water is shown by the arrows. When a sufficient supply of water is brought to the head of the fishway we will have an average depth of waterway above the floor *d* of 10 to 12 inches. Any excess of water over the amount needed to fill the fishway will be shed over the sides, and the fishway will continue in efficient operation in any stage of water.

In the drawings (Figs. 7, 8, and 9) the open spaces between the bulkheads *i i*, &c., and also the head of the fishway, where the water passes under the floor *d*, directly from the dam, are represented as guarded by a wrought-iron grating. This is only necessary where the exposed position requires that the weak points be protected from injury by ice or drifting timbers. The grating may be dispensed with where other safeguards are made use of.

7. LOCATION.

The proper setting or location of the fishway is a matter of prime importance to secure satisfactory operation. Where the cost of the construction is considerable the location should be made under the direction of a competent engineer and after a careful study of the locality.

In all cases the following conditions are to be observed in the construction: (1) The water capacity of the fishway must be in proportion to the volume of the stream. The more water we can discharge through the fishway the more satisfactory it will be in operation. (2) The upper end of the fishway must be set at such level as to run full at ordinary spring stages of the stream. (3) The discharge from the fishway should be made close to the face of the dam. (4) The fishway must be so located as to be sheltered from ice and drift, or, when this is impracticable, it must be built strong enough to resist injury. Where these conditions are realized in the construction complete satisfaction in operation may be expected.

In Figs. 10, 11, and 12 are presented three plans of actual constructions, which will furnish useful suggestions as to location.

Fig. 10 shows plan of fishway on the Rappahannock River, near Fredericksburg, Va. The water is brought to the head of the fishway by a culvert piercing the flood-wall. The fishway is built on a slope of 1 foot in 3, and in two sections, so as to bring the discharge close to the abutment. This has been in successful operation two seasons.

Fig. 11 shows plan of fishway at Bosher's Dam, on James River, Virginia, 9 miles above Richmond. This is a later and improved design, though embodying the same principles of construction as shown in the Fredericksburg way. Here advantage was taken of the locality to shelter the way behind the high flood shown in the drawing. Two

arched culverts admit the water to a sluice which conducts it to the head of the fishway. This discharge of water is too far from the face of the dam to secure the best results, and it will be necessary to erect a deflecting wall at the lower end, to turn the current around the abutment. This fishway has been in operation since the middle of May, 1883, and since the water has been turned on all the river species except the shad have been observed passing in large numbers. Very few shad have reached the dam this season, the total catch by the nets being less than two hundred.

Fig. 12 shows plan of fishway on canal dam No. 4, on the Potomac River, near Shepherdstown, W. Va. This was built in the winter of 1882, stood without injury the heavy ice drifts and floods of the late winter, and during the season just past has given full satisfaction to those who have watched its operation. The black bass and other river species have been observed to pass it in numbers and with ease. In this case the fishway is sheltered behind the abutment on the Maryland side of the river, the upper section being suspended to the abutment by stout wrought-iron brackets. The water is conducted to the head of the fishway from the crest of dam by a trunk leading around the face of the abutment.

UNITED STATES FISH COMMISSION,
Washington, D. C., August 25, 1883.

EXPLANATION OF THE PLATES.

PLATE I.

Figure 1. Illustration of the combined influence of gravity and friction upon a solid molecule while traversing a constrained path, the final direction being against gravity.

Figure 2. Illustration of the continual acceleration of a solid molecule rolling down a smooth incline under the action of gravity.

Figure 3. Illustration of the manner in which we may deliver a solid molecule from a higher to a definite lower level without acceleration by application of the principle developed in figure 1.

Figure 4. Illustration of the same fact in regard to liquid molecules.

PLATE II.

Fgure 5. Genesis of the fishway, showing how the principles developed in figures 1, 3, and 4 may be applied to deliver a current of water down a straight sluiceway, with a velocity constant after the initial acceleration at the head of the sluiceway.

PLATE III.

Figures 6*a* and 6*b*. General plan and elevation of the McDonald fishway.

PLATE IV.

Figures 7, 8, and 9. Plan and sections of a double fishway to show details of construction. Scale ½-inch to 1 foot. This way is built of oak or other durable lumber.

The head of the way and open center is protected by wrought-iron gratings, as shown in plan and elevations. Either half of the way may be constructed and operated independently of the other half.

PLATE V.

Figure 10. Outline plan of fishway on the Rappahannock River, near Fredericksburg, Va. Height of dam, 19 feet 6 inches. The inclination of this fishway is one foot in three; width of waterway, 7 feet. The discharge of water from the fishway is close to the abutment of the dam, and the structure is completely protected from ice and floods by its location behind the guard walls.

PLATE VI.

Figure 11. Plan in outline to show location of fishway at Boshler's Dam, James River.

PLATE VII.

Figure 12. Outline plan showing location of fishway at Canal Dam No. 4, Potomac River.

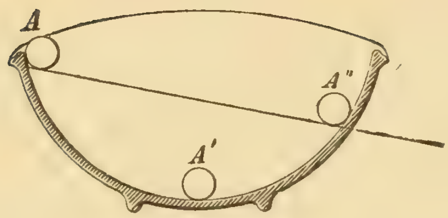


Fig. 1.

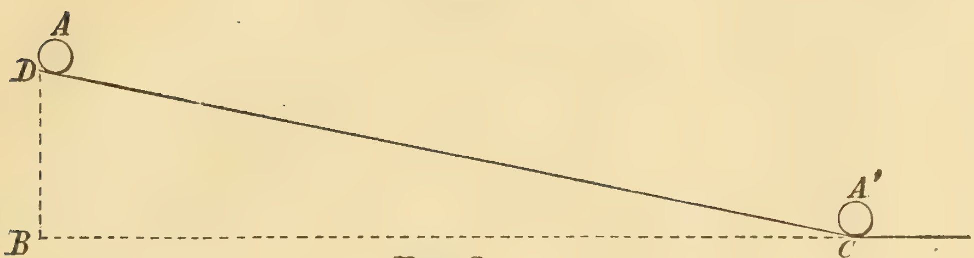


Fig. 2.

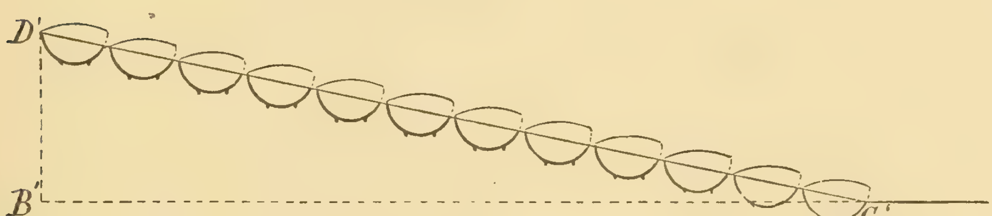


Fig. 3.

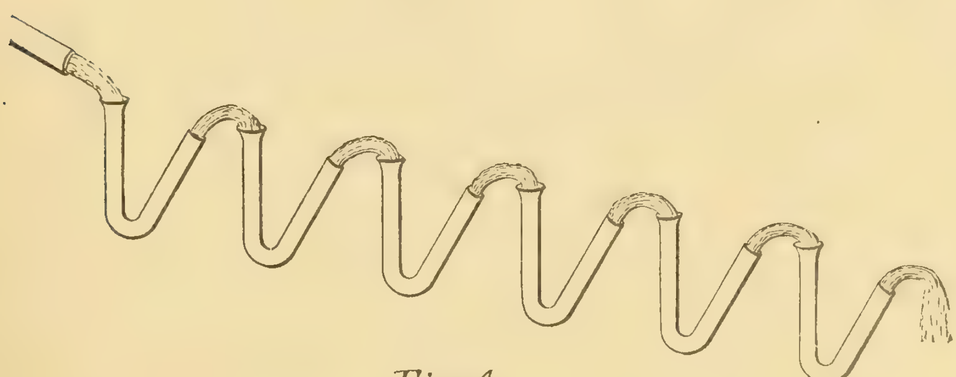


Fig. 4.

Illustrations of the physical laws applied in the McDonald fishway.

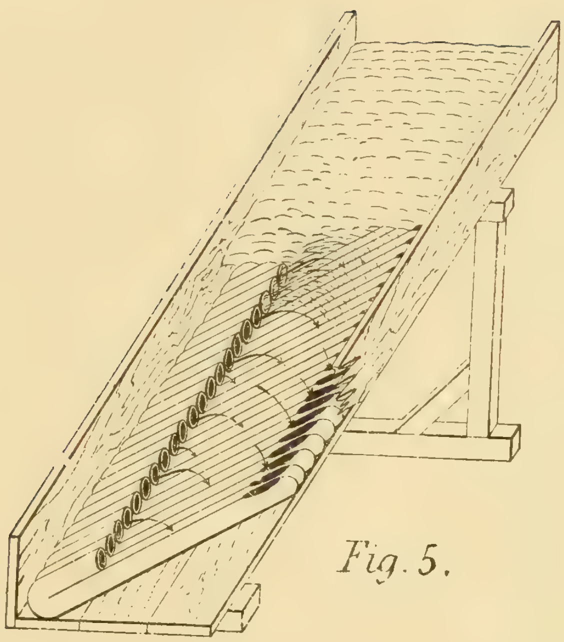
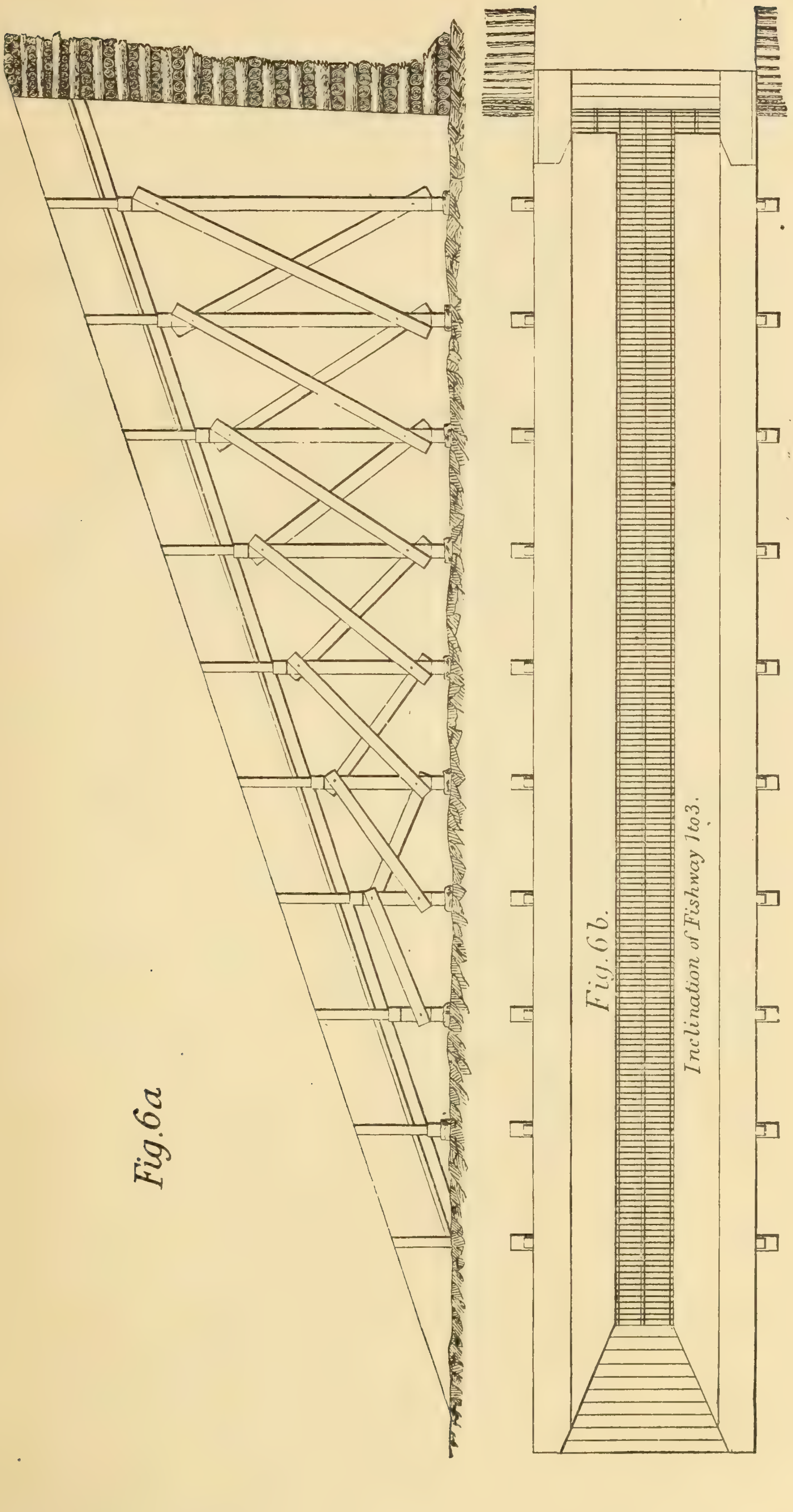
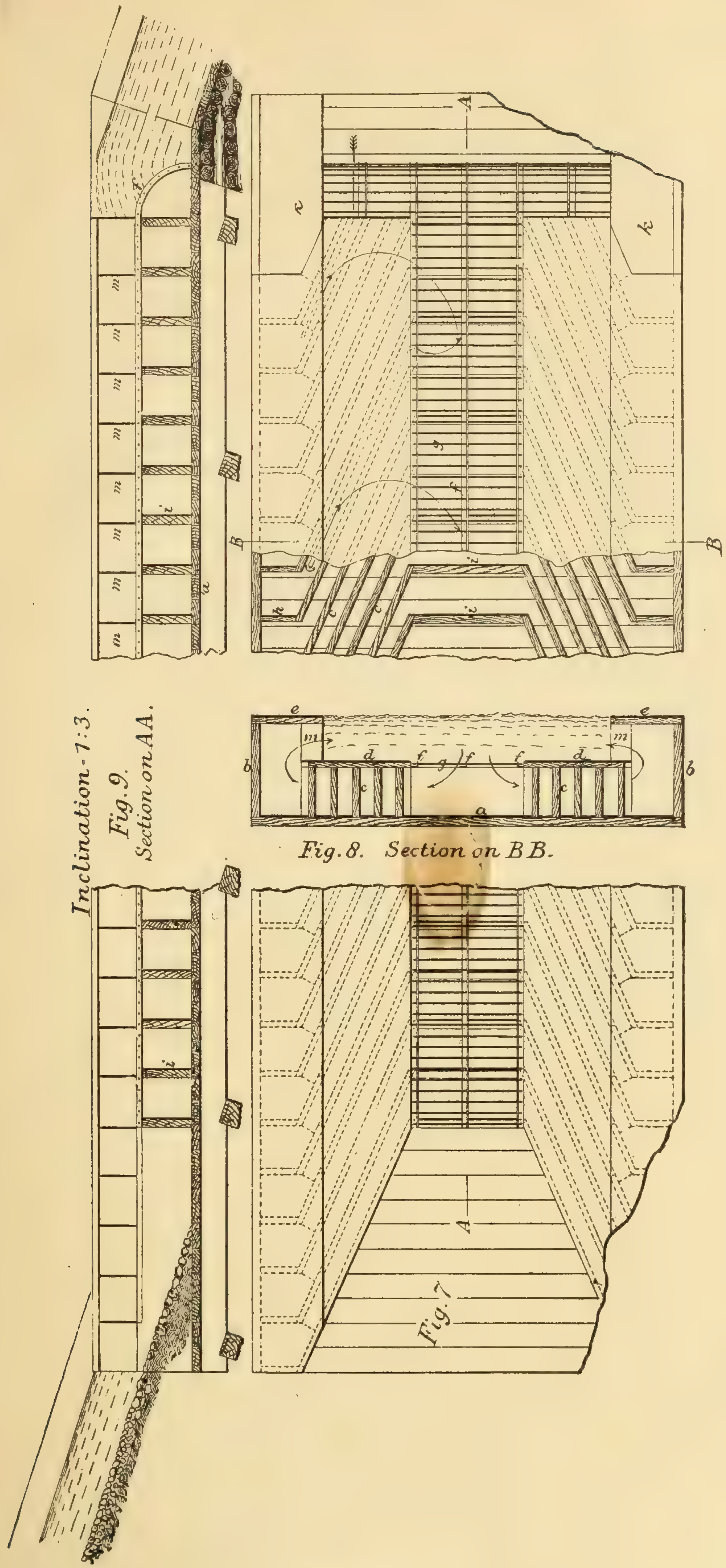


Fig. 5.

Genesis of the McDonald fishway.



General plan and elevation of McDonald fishway.



Plan and sections of a double way, to show details of construction.

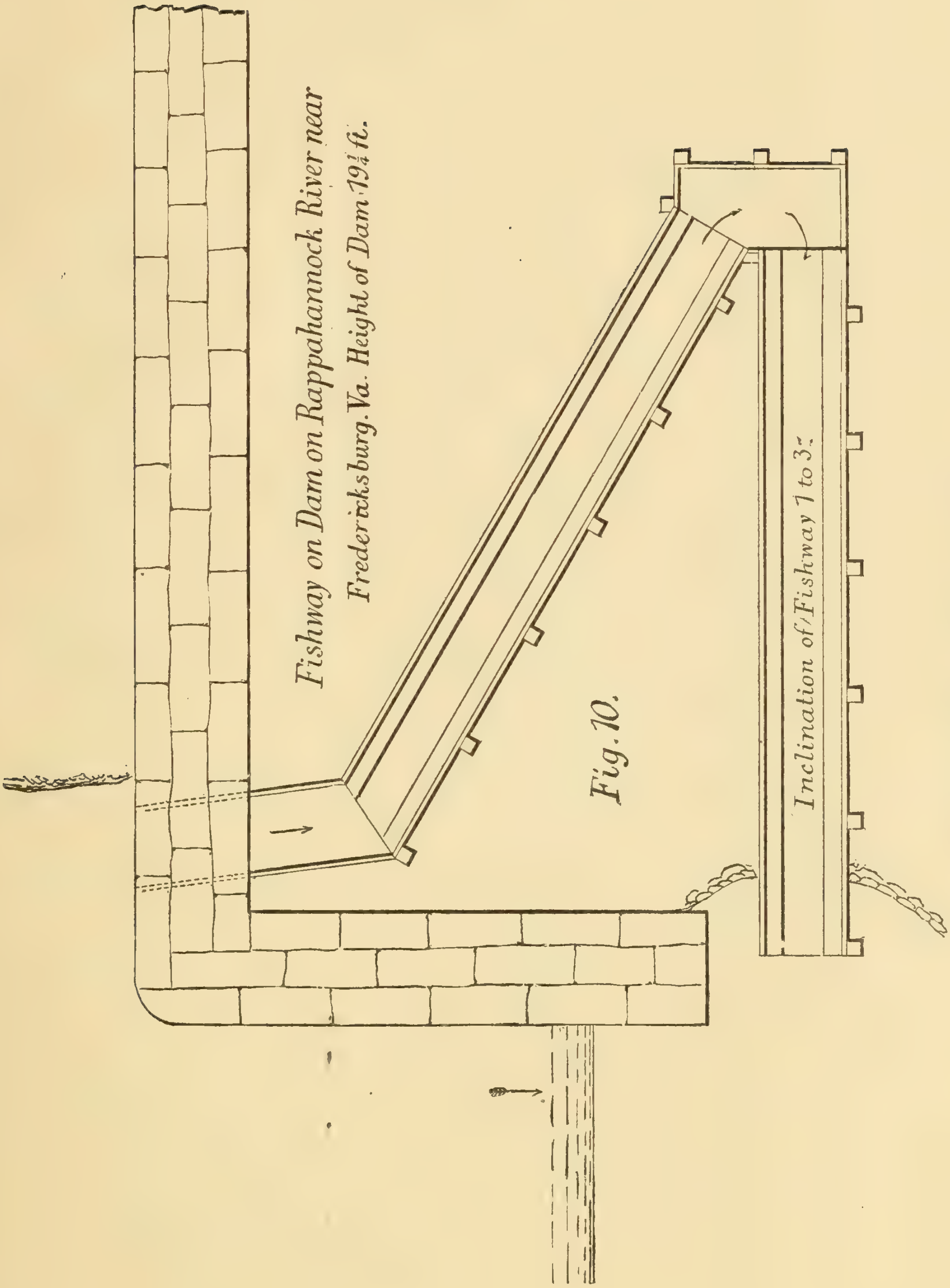


Fig. 10.

Plan in outline, to show location.

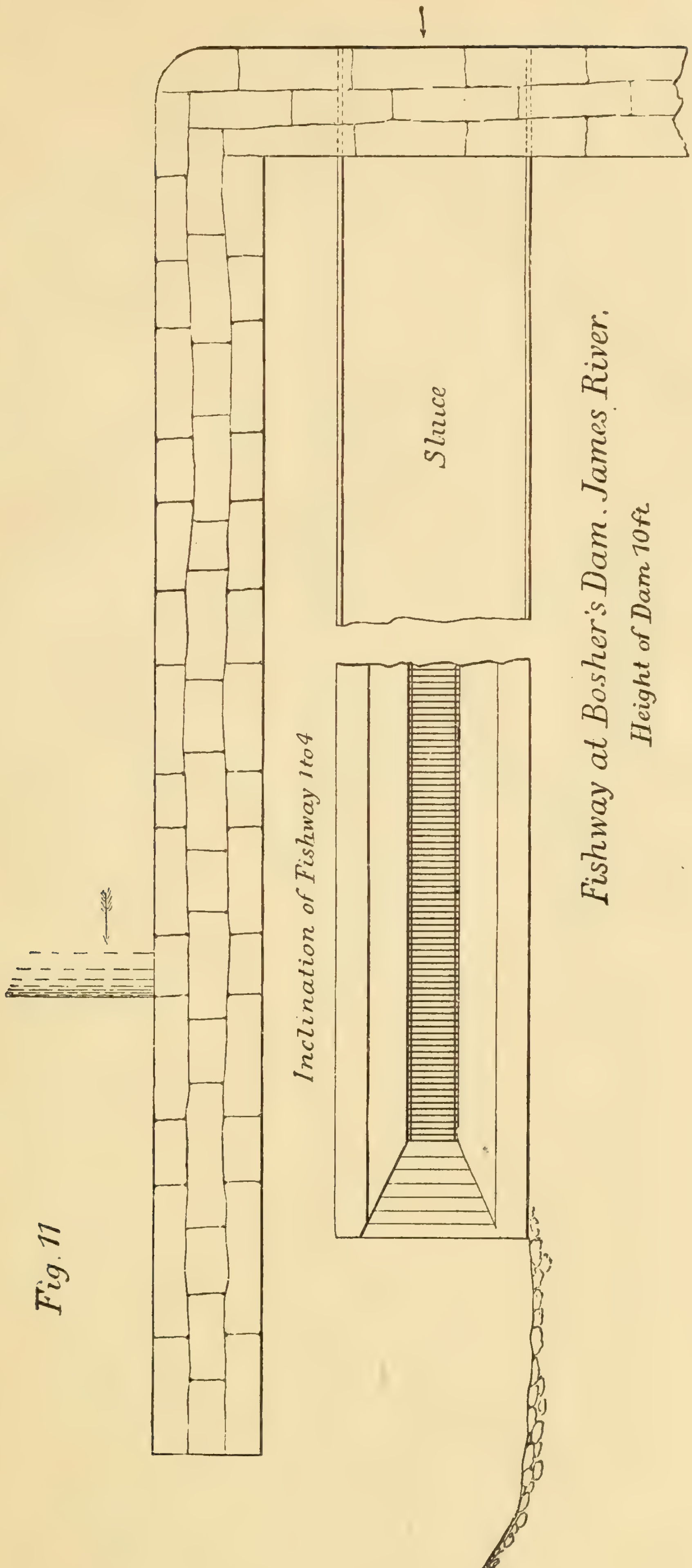


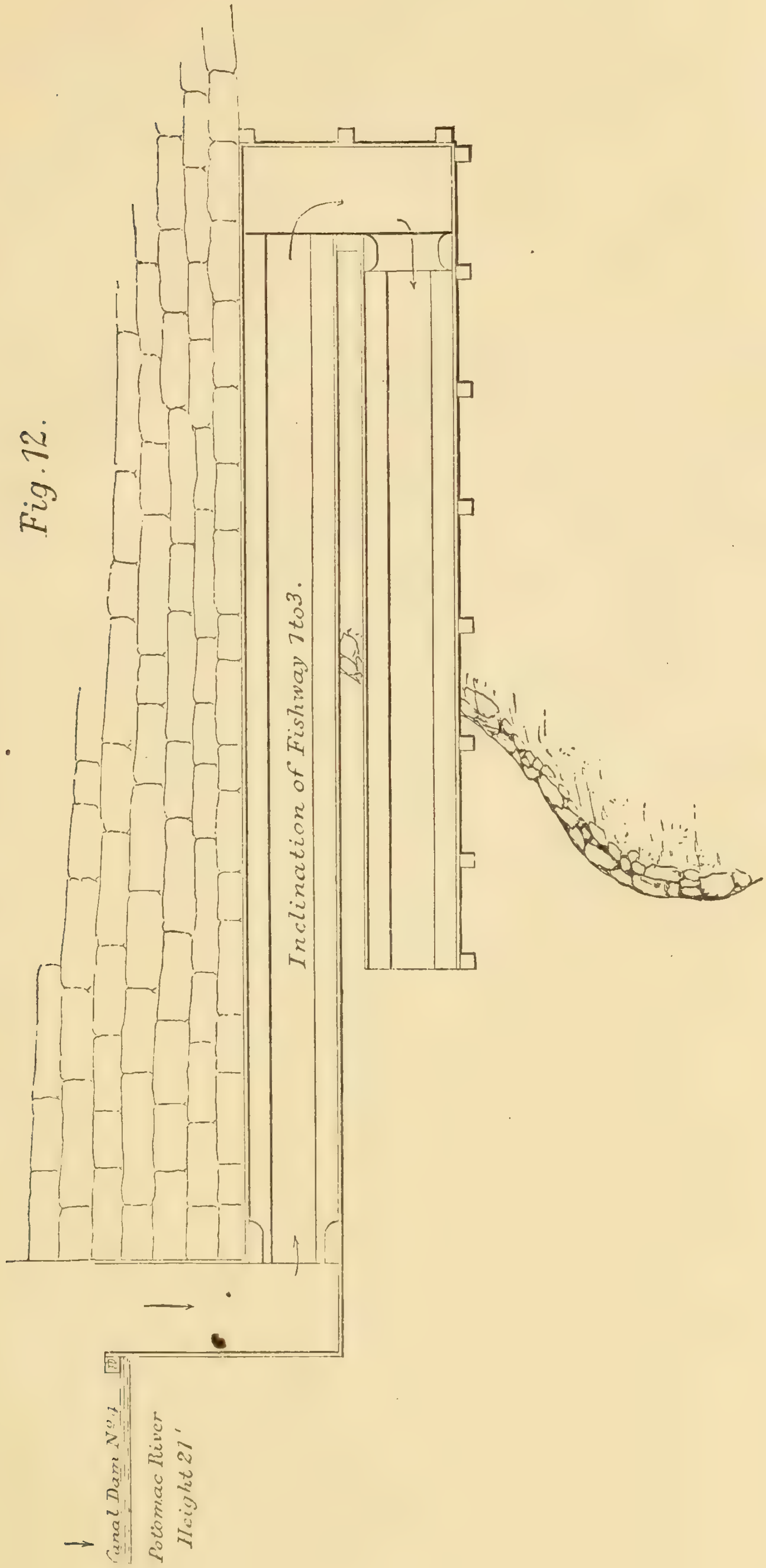
Fig. 11

Fishway at Bosher's Dam. James River.

Height of Dam 10 ft.

Plan in outline, to show location.

Fig. 12.



Outline plan showing location of fishway at Canal Dam No. 4, Potomac River.

V.—THE UNITED STATES EXHIBIT AT THE BERLIN INTERNATIONAL FISHERY EXPOSITION OF 1880.*

[Fom the "*Vossische Zeitung*," June 3, 1880.]

The oldest, most important, and most faithful ally of the German Fishery Association is North America, and more especially the United States Commission of Fish and Fisheries at Washington, at the head of which is Prof. Spencer F. Baird, who deserves great credit for his efforts in behalf of pisciculture. This gentleman, whose name is well known in Europe, is also Director of the National Museum and Secretary of the Smithsonian Institution. The three institutions over which he presides are closely connected with each other, the two last mentioned extending their aims beyond fishery and fish-culture, and devoting themselves also to other fields of science. Nothing could have raised our expectations, here in Berlin, to a higher pitch than the news which reached us some months ago, that we should be privileged to view the piscicultural achievements of the United States, to which von Behr, of Schmoldow, had so often directed our attention. Our expectation has now been realized, and we are happy to see among the representatives of the United States who present to our view the American exhibit, as the result of the labors of the National Museum at Washington, a gentleman already well known in our capital, one of Professor Baird's assistants, the famous pisciculturist Fred. Mather, who has repeatedly crossed the ocean in order to enrich German fish-culture with the treasures of the American rivers, and to whom we owe, among other things, the successful introduction into Germany of the California silver-salmon, *Salmo quinnat* [*Oncorhynchus chouicha* (Walb.) J. & G.], which thrives so well in our streams. The large and rich exhibit of the United States at our Fishery Exposition, which occupies nearly one-fourth of the first floor of the Museum of Agriculture, is systematically arranged in classes, according to the programme; and it might have been predicted that the majority of the articles exhibited would testify to that common sense and practical genius which long since have made our trans-oceanic friends the foremost inventors of the world. It is, indeed, not saying too much if we state that the united achievements, in this field, of all other nations cannot be compared with the astonishing

* *Die internationale Fischerei-Ausstellung zu Berlin:*
VI. *Nord-Amerika.* Translated from the German by HERMAN JACOBSON.

wealth of practical articles placed on exhibition by the National Museum in Washington. Whilst with nearly all other nations fishing is considered such a venerable occupation that it is almost considered a crime to make any change in the catching implements and instruments which have been hallowed by the traditions of ages, the practical sense of the American does not have the slightest regard for such traditions, but simply goes on inventing something new all the time.

When the American wants to cut or carve a fish, he of course uses a knife; but far from contenting himself with a single kind of knife, he thinks that every fish demands a special kind of knife. It will almost seem ludicrous to our readers if we state that America has exhibited no less than ten different kinds of knives for slaughtering fish; but each one of these knives finds a peculiar and practical use. Many hundreds of thousands of mackerel, codfish, and shell-fish can be "prepared" much quicker, if the right kind of instrument is used. This does not, however, exhaust the list of knives; but the Exposition shows us knives for pealing off the fat of the whale, boat knives to cut the harpoon-line of the whale-boats in case it has became entangled, knives for decapitating fish, for cutting their throat, for scraping off the scales, for making slits, &c. But this is not yet sufficient; the exhibitors have taken special pains not only to show that the inventive genius of the American nation has created something entirely new in the ethnological field, but also to satisfy the historical interest. For this reason the implements and tools made by the ancient aborigines have been gathered and embodied in this collection, including the stone and bone knives of the Indians and Esquimaux; the spears and javelins of the Esquimaux on the Mackenzie River near the Arctic coast, and on the northwest coast; the salmon-spears of the Passamaquoddy Indians; the fish and bird spears of the Alaska Indians; Esquimaux harpoons, made of stone, bone, and iron; spear-heads of the natives, made of American copper; spear-heads and hooks made of the split bones of various animals, and harpoon-points with fins made of fish-bladder; arrows with which the Esquimaux kill fish, &c.

As these Arctic natives live exclusively by the fisheries and the chase, we may be certain in case the collection of the National Museum in Washington is complete, that we see here, besides the numberless inventions and implements of recent date, an almost exhaustive collection of implements used by the ancient aborigines of the farthest regions of the North. If we suppose this to be correct, this small portion of the great exhibit would permit us again briefly to touch the most important questions of anthropology. It is well known that when, some years ago, the German anthropologists met in convention at Constance, they devoted a good deal of attention to the drawings of animals which prehistoric man, at a time when the mammoth had not yet become extinct, is said to have rudely etched with stone on ivory, horn, or bone. At that time the advocates of the genuineness of the "famous grazing

reindeer" of Thayingen, mentioned in support of their assertions the skill shown by the Esquimaux of our days in adorning their various bone implements with sketches of human beings, animals, houses, and other things. Reference was made at the time to a number of articles of this kind which had been in some of our museums for a considerable period, and to reproductions of the same which, besides the famous French drawings of the mammoth, &c., had found their way in various works treating of prehistoric times, such as Lubboch's *Prehistoric Ages*, Beer's *Prehistoric Man*, and others. If any collection could have shown us implements adorned in the manner above described, it would certainly have been the American exhibit; but, unfortunately, nothing of the kind is found in it. Some of the articles placed on exhibition show considerable skill in carving, strongly reminding us of the style of ornamentation common on nearly all coasts of the Pacific Ocean. It is a peculiar, but not altogether inexplicable, circumstance, that the wooden fish-hook of the natives of the farthest Northwest of North America is frequently ornamented with wooden figures, and that we also find here some very beautiful and characteristic boat-ornaments of carved wood. It is presumed that Mr. Günther, of Dorotheen street, the official photographer of the Exposition, will produce pictures of these ornaments which are of such interest to our anthropologists.

After this digression, which has shown us one of the many branches in which the American exhibit has produced so much interesting matter, we will return to our report proper, and, lingering for a few moments in this class, we cannot fail to notice the 200 artificial flies, exclusively used for catching salmon, trout, and bass, manufactured by Messrs. Bradford & Anthony, of Boston, and the collection of 120 flies for catching *Salmo thymallus*, exhibited by Messrs. Conroy, Bisset & Malleson, of New York, showing an endless variety in this one specialty. Owing to a lack of proper space, one of the most interesting of the fishing-boats placed on exhibition, a canoe made of birch bark, from the northern part of the United States, containing the characteristic figures of two reddish-brown Indians engaged in fishing, has unfortunately got rather an unfavorable place. We need scarcely tell our readers that the exhibit comprises a large variety of models of canoes, and of Esquimaux kayaks and "ummisks." Friends of aquatic sports will be interested in the exceedingly practical portable boats; no more can be desired than the portable boat, exhibited by Osgood & Chapin, Battle Creek, Mich., which measures 15 feet in length. It weighs 20 pounds, is intended for four men, and can be propelled very rapidly by two oars. Even when loaded with a weight of 850 pounds it only draws 8 inches of water. The price of such a boat is $45. One of the most important boats used in the United States for fishing is the "dory," which somewhat resembles our Pommeranian coast-boat. No fewer than six such "dories," completely equipped for different fishing purposes, are found in the exhibition; one, completely rigged, in the upper

story, the others below; some of them in the International Hall, which contains a completely equipped American whale-boat, as center-piece between the two large northern whales. Although this boat looks very pretty and almost new, we are informed that it has been engaged in many a hard contest with the largest of all living beings.

But we must not be detained too long in this class, for the others also richly deserve our attention, especially the one comprising the marine animals. To carry live fish all the way from the United States to the Berlin Exposition would seem a problem fraught with insurmountable difficulties, considering that many of our neighbors did not attempt to bring live fish. Nevertheless, Mr. Fred. Mather, the experienced transporter of fish, was not deterred by the difficulties attending such an experiment. He forthwith constructed a suitable transporting apparatus, a large metal vessel, which was filled three-fourths with water. Immediately over the water there were attached to the walls of the vessel sponges, which, through the rocking motion of the ship, were alternately filled with water and let it drip down. Through this contrivance the 124 fish which lived in the vessel were supplied with air, and succeeded in reaching Europe in good condition; but immediately upon their arrival they died. With the exception of American oysters exhibited in the Ice Hall, it had been found impossible to exhibit any live specimens of American marine animals, whilst a very large variety of salt, pickled, and otherwise prepared fish were exhibited in the hall for preserved fish. As in nearly everything else, America is also quite original in this branch of industry. This is especially shown in the very appetizing manner in which codfish is prepared. Beautiful pieces of clean white meat (all the refuse matter is otherwise utilized) ready for use actually tempt one to eat some of this fish, which, by most people, is not considered a delicacy. Soaked in water for six to eight hours, and then put on the fire for twenty minutes, this fish makes a cheap and palatable dish. Our Berlin fish dealers ought certainly to import some of it. Among other American prepared fish we must mention salmon, ready for the table, to be eaten either warm or cold, from A. Booth & Co., Astoria, Oreg., and fresh mackerel from W. K. Lewis & Brothers. (It may here be stated that Mr. Fritmann, of the *Tyska Fisk-rökeriet*, has in vain attempted, at considerable expense and labor, to introduce into Germany freshly caught Swedish mackerel.) We must also mention canned American oysters, exhibited by a firm in Baltimore. It is well known that the Americans also eat the beard of the oyster, and these oysters are, therefore, put up with the beard. On this account, and for other reasons, we cannot accustom ourselves to these oysters, even after the beard has been removed and they have been fixed with pepper and lemon-juice. It is probable, however, that if fried tolerably hard, they might find favor with some of our people. On the other hand, we must give the highest praise to the fresh lobsters from Underwood & Co., Boston; spiced sardines, exhibited by an unknown firm; and sour eels in jelly, from S. Schmidt, New York.

Among the other products of the fisheries we must mention the excellent preparation of the air bladder of various fish exhibited by Messrs. Howe & French, of Boston, which has met with great favor among connoisseurs, and threatens to enter into successful competition with various Russian products of this kind. We are informed that this article, also called isinglass, is used in nearly all American breweries for making the beer clear. We cannot pass by Le Page's fish-glue exhibited by John J. Tower, of New York. This article surpasses anything ever seen in this line, and is even used for joining machine-belts, without requiring any sewing.

The principal attraction of the American exhibit is the large collection of useful and hurtful American marine animals, comprising 296 of the more important American fish, reproduced in plaster, photographs, and colored drawings. The plaster casts, especially, attract universal attention. It is to be hoped that our scientists will imitate the example set by America in this respect, for our people would thus be able to become more thoroughly acquainted with the different kinds of fish than is possible without such plaster casts. Nothing is easier than to take a plaster cast of a fish, and if it is colored true to nature, no more exact image can be produced. Look at this plaster cast of a codfish, of a large size, which hangs on the wall. Everything at once reminds you that you have before you a specimen of the cod family, the powerfully developed head, the peculiar formation of the back, the color of the skin; but not of that cod family, hungry specimens of which visit our Baltic coasts, hunting for herring and flounders. A fat and well-fed codfish, like this one, we can only imagine as having been produced by some experienced fish culturist. Such a powerful body, such a mass of firm and juicy meat, can only be produced by the rich food found in the sea near the coasts of Maine and Massachusetts. Here we also see the favorite fish of the Americans, the shad (*Alosa sapidissima*), our German "May-fish," which von Behr is endeavoring to introduce in Germany, and hopes to make a popular article of food. Here we also find *Salmo salar*, the Atlantic salmon, which ascends, for the purpose of spawning, the rivers of North America, Europe (the Rhine), and Asia; likewise the California silver salmon, which grows very rapidly and can stand great changes of temperature; 5 varieties of American pike; and some specimens of the menhaden, which are caught by the million to serve as bait for codfish. Here is also another present from America, the American brook-trout (*Salmo fontinalis*), 8,000 eggs of which we received two years ago, and which lives in the rivers and lakes of British North America, in the northern part of the United States, and in the Appalachian range. Here we finally find von Behr's ideal (or at least one of his ideals), the famous striped bass or rock-fish (*Roccus lineatus*), which is found from Florida to Nova Scotia, and which, if imported into Germany, would be a most useful acquisition. Any one who desires to see this gigantic fish may do so by visiting the

Ice Hall, where there is a specimen, prepared by Mr. Wickersheimer. This fish succeeded in crossing the ocean in good condition, but died upon its arrival here.

The great wealth of fish has by no means induced our American friends to rest contented with sitting down to the rich banquet which nature has provided for them, but they make every effort to give back to the water what they have taken from it. In the first place, they have gotten our carp, in return for the two fish which they have sent us; and this hardy European mud-fish seems to flourish very well in America. They have also imported the *saibling*, and, as far as I know, the *märane*. Marine animals have been raised artificially on a very large scale; numerous piscicultural establishments have been founded in various parts of the country; and the practical American pisciculturists, such as Professor Spencer F. Baird, Fred. Mather, Clarke, T. B. Ferguson, Holton, Chase, Pike, C. G. Atkins, M. McDonald, and others, have invented a large number of different hatching and other piscicultural apparatus, and have practically tested most of them. The number of such apparatus in the Fishery Exposition is very large, many of them being already theoretically known to us from the descriptions given in the publications of the "German Fishery Association." But the practical Americans go still further. Each one of their many hatching establishments hatches every year millions of salmon, trout, and other fish eggs. But not satisfied with this, the United States has built a a fish-hatching steamer, the Fish Hawk, which, fitted with all sorts of apparatus, makes long trips along the coast and up the rivers endeavoring to solve the various piscicultural problems. The exhibition shows us the model of this steamer, as well as a model of its central portion containing the hatching apparatus.

Our limited space unfortunately compels us to close our review; but we cannot leave this subject without having directed the attention of visitors to the exhibition to the apparatus for making deep-sea soundings, exhibited by the Coast Survey (of the Treasury Department); to the rich literature; to the beautifully executed maps of the North American fishing grounds; and finally to a very original production, viz, five water-color paintings, showing the spawning places of the sea-bears on the Pribiloff Islands in Alaska. A full report on the nature and characteristics of that out-of-the-way corner of the world was made a few months ago at the session of the Society for Commercial Geography in Berlin, by Mr. Émil Brass; and Mr. Henry W. Elliott's water-color sketches fully corroborate Mr. Brass's report. The American exhibit also contains the skins of seals, otters, sea-bears, weasels, minks, beavers, &c. It is, of course, impossible to give within the limits of a short newspaper article even an outline of all that is contained in this interesting exhibit; for we would not attempt to compress into one short article matter sufficient to fill a large volume.

VI.—LIST OF 1817 OF THE PRINCIPAL LAKES OF THE UNITED STATES, WITH A DESIGNATION OF THEIR LOCATIONS.

By Chas. W. Smiley.

ARIZONA.

Laguna. B-16.*
Laguna. P-14.
Laguna. R-5.
Laguna. R-6.
Laguna. S-7.
Laguna. T-6.
Laguna Esperanco. K-25.
Ojo Limita. S-5.
Red. D-9.

ARKANSAS.

Big. V-5.
Buford. U-5.
Carson's. V-7.
Clear. W-5.
Flat. W-5.
Golden. V-7.
Grand. V-10.
Grassy. W-5.
Horseshoe. U-10.
Hudgen's. W-6.
Long. W-5.
Mason's. R-17.
Old Town Cypress. T-12.
Tyronza. V-6.
Walker's. W-5.
Youngs. W-7.

CALIFORNIA.

Alkali. L-11.
Anne. H-5.
Bigler. K-10.
Buena Vista. M-22.
Castego. O-23.
Clear. D-10.
Clear. H-1.
Clear. K-11.
Crane. K-1.
Crescent. M-14.
Delta. J-3.
Dotep. F-1.
Dry. P-23.
Dry. Q-22.
Dry. Q-23.
Dry. R-21.
Dry. R-22.
Dry. S-24.
Dry. T-22.
Dry. W-25.
Dry. X-24.
Dry Salt. L-22.
Dry Salt. Q-21.
Dry Salt. S-18.
Dry Salt. S-19.
Dry Salt. W-19.
Eagle. I-5.
Easson. K-3.
Echo. K-11.
Elizabeth. O-23.
Fall. H-4.
Fallen Leaf. K-10.
Freaner. G-4.
French. J-9.
Gold. J-8.
Goose. J-1.
Goose. M-21.
Grand. N-14.
Harkness. H-6.
Highland. L-12.
Honey. J-6.
Horse. J-5.
Independence. K-9.
Kern. N-22.
Lagoon. A-1.
Laguna. Y-26.
Lily. K-4.
Little Klamath. G-1.
Long. J-8.
Louisa. H-6.
Lower. K-3.
Meadow. J-9.
Middle. K-2.
Mono. N-13.
Monterey. J-19.
Mount. O-20.
Red. L-11.
Rhett. H-1.
Salt. Q-17.
Silver. M-14.
Snake. H-7.
Stone. A-3.
Summit. K-11.
Summit. K-18.
Swan. H-5.
Tahoe. K-10.
Truckee. J-9.
Tulare. L-19.
Tule. F-1.
Tulip. D-10.
Twin. K-11.
Upper. K-1.
West Blue. K-11.

* These designations refer to the maps of Rand, McNally & Co.'s Atlas, editions of 1881 and 1882.

COLORADO.

Grand. F-18.
Ignacio. V-9.
John. C-15.
San Cristobal. S-11.
San Luis. U-19.
Santa Maria. T-12.
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Trout. T-8.
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Pokatapaugh. O-6.
Saltonstall. K-10.
Snipsick. P-3.
Twin. E-1.
Waremaug. E-5.
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Andes. R-25.
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Big Stone. W-16.
Chedi. S-16.
Devil's. Q-5.
Dry. J-8.
Hendricks. W-20.
Jessie. R-7.
Jim. Q-9.
Johnson. R-8.
Kampeska. U-18.
Lac des Roches. Q-2.
Long. M-11.
Minnie Waukan. Q-5.
Poinsett. V-19.
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Rush. R-2.
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Sandberry. K-7.
Scattered Wood. P-17.
Spiritwood. R-9.
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Thompson. U-20.
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White. N-25.
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FLORIDA.

Ahapopka. S-18.
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Apthorp. S-24.
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Beauclair. S-17.
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Conway. T-19.
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Cypress. E-8.
Cypress. T-21.
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Dunns. S-14.
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Francis. S-24.
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Norris. R-16.
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Ocola. A-10.
Okeechobee. V-26.
Okliakonkonhee. S-22.
Orange. Q-14.
Panasofka. P-17.
Parke. Q-20.
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Poinsett. W-19.
Rosalie. T-21.
Sampsons. P-12.
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Santa Fé. Q-12.
Sarah Jane. Q-16.
Stearns. S-24.
Tiger. T-21.
Tohopekaliga. T-20.
Washington. V-20.
Weekiva. T-18.
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Weshayakapa. T-22.
Winder. U-19.
Worth. Y-27.
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IDAHO.

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Cœur d'Alene. F-9.
De Lacy. X-26.
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Manitau. L-7.
Maxinkuckee. K-6.
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Mud. J-4.
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Bancroft. A-15.
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Cairo. G-18.
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Clear. E-11.
Crystal. B-18.
Eagle. C-18.
East Okoboji. A-10.
Elk. C-11.
Elm. E-19.
Goose. A-11.
Indian. G-10.
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Keokuk. M-34.
Lard. F-11.
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Medium. C-13.
Mud. D-11.
Okoboji. A-10.
Owl. E-16.
Pelicon. B-11.
Pilot. K-15.
Rice. A-20.
Round. G-10.
Rush. D-12.
Sand Hill. H-3.
Silver. A-9.
Silver. A-20.
Spirit. A-10.
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Swan. A-13.
Swan. A-11.
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Trumbull. C-11.
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Twin Lakes. G-13.
Wabonsie. P-6.
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Bodeau. F-2.
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Caddo. E-2.
Caillou. R-18.
Canhisnia. G-15.
Cannisnia. F-4.
Catahoula. L-8.
Charles. H-14.
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Grass. J-8.
Jatt. J-7.
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Mud. I-16.
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Oskibe. O-13.
Pearl. L-10.
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Sabine. E-15.
Saline I-6.
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Allaguash. J-12.
Attean. F-18.
Baskahegan. U-18.
Bear. M-3.
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Boyd. N-21.
Brassua. H-17.
Cauquomogomoc. J-13.
Chamberlain. L-12.
Chesuncook. L-14.
Churchill. K-11.
Cleaveland. R-4.
Clifford's. V-22.
Crawford. V-22.
Eagle Lakes. P-5.
Endless. N-19.
Fish River. O-7.
Glazier. M-4.
Grand. T-21.
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Junior. T-20.
Kenebago. C-22.
Little Mooseluck. M-11.
Lobster. K-15.
Long. D-31.
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Mattagamon. O-13.
Mattawamkeag. R-15.
Medybemps. W-22.
Millinokett. O-16.
Molechunkemunk. B-24.
Moosehead. J-17.
Moose Pond. K-24.
Moostocmaguntic. C-24.
Motesentock. O-18.
Mud. L-13.
Nickatous. S-22.
Pamedecook. N-17.
Parmachene. B-22.
Pleasant. M-10.
Portage. K-13.
Portage. P-8.
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Rangeley. C-23.
Richardson. B-25.
Roach. L-17.
St. John. H-13.
Salmon. Q-17.
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Schoodic. U-17.
Sebago. D-33.
Sebec. L-21.
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Shallow. K-12.
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Spider. M-11.
Squawpan. R-10.
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Umbagog. A-25.
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Asnyconch P. F-18.
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Brewer's P. K-4.
Cape Poge P. W-37.
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Halway P. P-35.
Hammond P. W-6.
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Hummock P. Z-40.
Jamaica P. W-7.
Long P. P-31.
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Menemsha P. X-33.
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Mystic P. P-6.
Nippenicket P. N-30.
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Pottopaug P. G-16.
Quaboag P. K-18.
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Cheboygan. D-10.
Checagon. H-32.
Chippewa. N-6.
Clark. X-10.
Clear. O-6.
Coldwater. Z-8.
Crooked. D-8.
Crooked. V-6.
Crystal. H-3.
Deer. J-25.
Deer. M-30.
Devil's. Y-11.
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Elk. H-6.
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George. M-7.
Glen. G-3.
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Grass. G-7.
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Horse Head. O-7.
Horse Shoe. J-11.
Houghton. J-9.
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Lakeville. S-15.
Little. L-31.
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Mud. N-31.
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Paw Paw. W-2.
Perch. F-30.
Pere Marquette. M-1.
Pine. E-7.
Pine. J-13.
Pine. J-27.
Platte. H-3.
Portage. G-26.
Portage. J-2.
Rice. P-5.
Rose. L-6.
Round. H-6.
Round. L-4.
Rush. M-15.
Schuffer's. K-24.
Silver. J-29.
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South Manistique. S-31.
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Alexander. J-20.
Alley. J-29.
Amelia. G-24.
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Bass. N-14.
Battle. F-20.
Bay. M-19.
Bear. E-33.
Bear. K-15.
Bear. N-36.
Bell. J-28.
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Big Kandiyohi. H-28.
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Cedar. I-25.
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Cedar. J-28.
Centre. F-34.
Christiana. F-21.
Circle. O-31.
Clear. H-36.
Clear. M-25.
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Clitherall. F-20.
Colton. E-16.
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Cora Bell. E-34.
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Cormorant. E-22.
Crane. R-8.
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Eagle. M-32.
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Eden. J-25.
Elbow. E-22.
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Emerson. J-33.
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Leech. K-15.
Leven. G-23.
Lida. D-18.
Lillian. H-28.
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Long. I-34.
Long. J-27.
Long. L-19.
Long. L-20.
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McDonald. F-18.
Mary. F-33.
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Sauk. I-23.
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Humboldt. F-10.
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Massacre. B-3.
Middle. B-3.
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Tahoe. A-13.
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Clark's. N-29.
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Spat P. O-8. Mass.
Spaulding. K-30. N. H.
Spectacle. F-24. N. H.

Toshepa. M-9. Nev.
Tow Head. F-12. Iowa.
Townsend. E-27. N. H.
Transparent. T-12. N. Y.
Trappers. G-12. Colo.
Traverse. W-15. Dak.
Traverse. B-23. Minn.
Trio. L-8. N. H.
Trout. T-8. Colo.
Trout. O-13. Minn.
Trout. E-26. N. H.
Trout. F-27. N. H.
Trout. M-5. N. H.
Trout. N-18. N. H.
Trout. U-6. N. Y.
Trout. N-10. Wis.
Truckee. J-9. Cal.
Trumbull. C-11. Iowa.
Truston P. T-11. R. I.
Tucker. H-24. N. H.
Tucker's P. S-11. R. I.
Tuffs. N-31. Minn.
Tulare. L-19. Cal.
Tule. F-1. Cal.
Tulip. D-10. Cal.
Tupper's. U-8. N. Y.
Turkey. P-5. Ind.
Turtle. C-9. Mich.
Turtle. G-11. Mich.
Turtle. E-20. Minn.
Turtle. M-4. Minn.
Turtle. K-25. N. H.
Turtle. F-18. N. H.
Tuttle. J-36. Minn.
Twelve Mile. B-11. Iowa.
Twelve Mile. K-37. Pa.
Twin. K-11. Cal.
Twin. M-16. Colo.
Twin. E-1. Conn.
Twin. O-4. Dak.
Twin. O-17. Me.
Twin. F-14. Minn.
Twin. N-36. Minn.
Twin. E-18. Iowa.
Twin. P-10. Wis.
Twin Lakes. A-18. Iowa.
Twin Lakes. G-13. Iowa.
Two River K-23. Minn.
Tyronza. V-6. Ark.
Tysons. F-30. Minn.
Umbagog. A-25. Me.
Umbagog. O-7. N. H.
Upper. K-1. Cal.
Upper. P-6. Me.
Upper. I-25. N. H.
Upper. V-9. N. Y.
Upper P. S-13. R. I.
Upper Baker. G-17. N. H.
Upper Beech. N-20. N. H.
Upper Chatteaugay. W-5. N. Y.
Upper Kimball. O-15. N. H.
Upper Klamath. V-14. Oreg.
Upper Rice. H-13. Minn.
Upper St. Croix. D-9. Wis.
Upper Saranac. V-7. N. Y.
Upper Shields. M-29. N. H.
Upper Woods. F-36. Pa.
Upton. I-11. Nebr.
Utah. M-12. Utah.
Vacanga. H-27. Minn.
Vermillion. T-10. Minn.
Verret. P-15. La.
Vickers. F-25. N. H.
Vietes. C-10. Tex.
Wabonsie. P-6. Iowa.
Wachusett P. E-19. Mass.
Waconda. M-28. Minn.
Waddell. U-9. N. Y.
Wahaboncey. P-6. Iowa.
Walker. F-15. Nev.
Walker's. W-5. Ark.
Walker's. O-16. N. H.
Walker's. J-6. Vt.
Wall. F-19. Iowa.
Wall. H-10. Iowa.
Wallingford. F-23. Vt.
Walloon. E-7. Mich.
Wallum P. A-4. R. I.
Wapaug. O-13. Minn.
Waremaug. E-5. Conn.
Warren. E-26. N. H.
Warwick P. J-15. R. I.
Wash. N-29. N. H.
Washa. T-16. La.
Washington. V-20. Fla.
Washoe. B-12. Nev.
Watchaug P. T-6. R. I.
Waterman Res. E-10. R. I.
Watuppa P. R-29. Mass.
Wawasee. O-5. Ind.
Wawayanda. O-3. N. J.
Webbs. D-10. Wis.
Weekiva. T-18. Fla.
Weeks. I-22. N. H.
Weir. Q-16. Fla.
Weld. E-25. Me.
Wells River. L-13. Vt.
Wenatshapan. N-8. Wash.
Wenscott Res. E-13. R. I.
Wentworth. N-6. N. H.

VII.—LIST OF THE PRINCIPAL RIVERS OF THE UNITED STATES WHICH EMPTY INTO THE ATLANTIC OCEAN, PACIFIC OCEAN, AND GULF OF MEXICO, WITH THEIR TRIBUTARIES.

BY CHAS. W. SMILEY.

NOTE.—Indented names denote tributaries. Valuable assistance has been rendered in the preparation of this list by Mr. J. E. De Jesta, Mr. S. S. Alden, Mr. E. Y. Davidson, and Mr. C. E. Latimer.

1. Saint John River, New Brunswick.
    1 A. Southwest Branch River Saint John, Maine.
    1 B. Southeast Branch River Saint John, Maine.
    1 C. Wooboostook River, Maine.
    1 D. Matawagwam River, Maine.
    1 E. Saint John Pond, Maine.
    1 F. Big Black River, Maine.
    1 G. Little Black River, Maine.
    1 H. Fish River, Maine.
    1 J. Aroostook River, Maine.
        1 K. Little Madawaska River, Maine.
        1 L. Big Machias River, Maine.
        1 M. Mooseleak River, Maine.
        1 N. Saint Croix Creek, Maine.
        1 O. Little Machias River, Maine.
        1 P. Masardis River, Maine.
    1 Q. Presque Isle River, Maine.
    1 R. Meauxnakeag River, Maine.
    1 S. Allaguash River, Maine.
        1 T. Webster Creek, Maine.
        1 U. Chimquassabamtook River, Maine.
        1 V. Musquacook River, Maine.
        1 W. Allaguash Lake, Maine.
        1 X. Heron Lake, Maine.
        1 Y. Long Lake, Maine.
        1 Z. The Five Lakes, Maine.
    1 A2. River Saint Francis, Maine.
2. Saint Croix River, Maine.
        2 A. Kennebasis River, Maine.
2½. East Machias River, Maine.
3. Machias River, Maine.
3½. Pleasant River, Maine.

4. Narraguagus River, Maine.
5. Union River, Maine.
6. Penobscot River, Maine.
   - 6 A. East Branch of Penobscot River, Maine.
     - 6 B. Wassataquoik River, Maine.
     - 6 C. Seboois River, Maine.
     - 6 D. Trout Creek, Maine.
   - 6 E. Salmon River, Maine.
   - 6 F. West Branch of Penobscot River, Maine.
     - 6 G. Lobster Pond, Maine.
   - 6 H. Mattawamkeag River, Maine.
     - 6 J. East Branch, Maine.
     - 6 K. West Branch, Maine.
     - 6 L. Wytopitlock Stream, Maine.
     - 6 M. Moluncus River, Maine.
   - 6 N. Piscataquis River, Maine.
     - 6 O. Pleasant River, Maine.
       - 6 P. West Ebeme and East Ebeme, Maine.
   - 6 Q. Passadumkeag River, Maine.
   - 6 R. Chesumcook Lake, Maine.
   - 6 S. North Branch of Penobscot River, Maine.
     - 6 T. Northwest Branch, Maine.
     - 6 U. Northeast Branch, Maine.
   - 6 V. Southwest Branch of Penobscot River, Maine.
   - 6 W. Saint George River, Maine.
7. Damariscotta River, Maine.
8. Sheepscott River, Maine.
9. Kennebec River, Maine.
   - 9 A. Moose River and Lake, Maine.
   - 9 B. Dead River, Maine.
     - 9 B*a*. Spencer Stream, Maine.
     - 9 C. Saddleback River, Maine.
   - 9 D. Sandy River Maine.
   - 9 E. Sebasticook River, Maine.
   - 9 F. Androscoggin River, Maine.
     - 9 G. Magalloway River, Maine.
     - 9 H. Kenebaga River, Maine.
     - 9 J. Cupsuptac River, Maine.
     - 9 K. Sunday River, Maine.
     - 9 L. Ellis Branch, Maine.
     - 9 M. Swift Branch, Maine.
     - 9 N. Bear Creek, Maine.
     - 9 O. Peabody River, New Hampshire.
10. Sebago River, Maine.
    - 10 A. Crooked River, Maine.
    - 10 B. Sebago Lake, Maine.

11. Saco River, Maine.
    11 A. Great Ossipee River, Maine.
    11 B. Little Ossipee River, Maine.
    11 C. Swift River, New Hampshire.
12. Kennebunk River, Maine.
13. Salmon Falls River, Maine.
14. Merrimac River, Massachusetts.
    14 A. Concord River, New Hampshire.
    14 B. Beaver Creek, New Hampshire and Massachusetts.
    14 C. Sudbury River, Massachusetts.
    14 D. Assabet River, Massachusetts.
    14 E. Nashua River, New Hampshire and Massachusetts.
    14 F. Concootook River, New Hampshire.
    14 G. Pemigewasset River, New Hampshire.
    14 H. Mud River, New Hampshire.
15. Parker River, Massachusetts.
16. Plum Island River, Massachusetts.
    16 A. Rowley River, Massachusetts.
17. Ipswich River, Massachusetts.
18. Saugus River, Massachusetts.
19. Mystic River, Massachusetts.
20. Charles River, Massachusetts.
    20 A. Beaver Brook, Massachusetts.
20½. Neponset River, Massachusetts.
    20½ A. Pine Tree Branch, Massachusetts.
    20½ B. Mill Creek, Massachusetts.
20⅔. B. Blue Hill River, Massachusetts.
21. North River, Massachusetts.
22. South River, Massachusetts.
23. Jones River, Massachusetts.
23½. Agawam River, Massachusetts.
23⅔. Sippican River, Massachusetts.
24. Weweautitt River, Massachusetts.
25. Acushnet River, Massachusetts.
26. Pamanset River, Massachusetts.
27. Westport River, Massachusetts.
28. Acoaksett River, Massachusetts.
29. Warren River, Massachusetts.
    29 A. Rocky River, Massachusetts.
30. Taunton River, Massachusetts.
    30 A. Three-mile River, Massachusetts.
    30 B. Wimtuxet River, Massachusetts.
    30 C. Palmer's River, Massachusetts.
31. Sakonnet River, Rhode Island.
32. Kickamut River, Rhode Island.

33. Providence River, Rhode Island.
 33 A. Pawtuxet River, Rhode Island.
 33 B. Pohasset River, Rhode Island.
 33 C. Big River, Rhode Island.
 33 D. Flat River, Rhode Island.
 33 E. Tunk Branch, Rhode Island.
 33 F. Moswansicut River, Rhode Island.
 33 G. Rush Branch, Rhode Island.
 33 H. Hunting House River, Rhode Island.
 33 J. Mosquito Hawk Branch, Rhode Island.
 33 K. Rush Branch, Rhode Island.
 33 L. Ponagansett River, Rhode Island.
 33 M. Cork Branch, Rhode Island.
 33 N. Hemlock Branch, Rhode Island.
 33 O. Hannah's Branch, Rhode Island.
 33 P. Paine Branch, Rhode Island.
 33 Q. Shippe Branch, Rhode Island.
 33 R. Seekonk River, Rhode Island and Massachusetts.
 33 S. Blackstone River, Rhode Island and Massachusetts.
 33 T. Mill Branch, Massachusetts.
 33 U. Millers Branch, Rhode Island.
 33 V. Moshassuck River, Rhode Island.
 33 W. Chepachet River, Rhode Island.
34. Brandy Branch, Rhode Island.
35. Gold Branch, Rhode Island.
36. Appanaug River, Rhode Island.
37. Potowomut River, Rhode Island.
 37 A. Hunt's River, Rhode Island.
38. Pawcatuck River, Rhode Island.
 38 A. Red Branch, Rhode Island.
 38 B. Usquebag River, Rhode Island.
 38 C. Meadow Branch, Rhode Island.
 38 D. Beaver Branch, Rhode Island.
 38 E. Queen's River, Rhode Island.
 38 F. Flat River, Rhode Island.
 38 G. Wood River, Rhode Island.
 38 H. Parris Branch, Rhode Island.
 38 I. Brushy Branch, Rhode Island.
38½. Mystic River, Connecticut.
39. Thames River, Connecticut.
 39 A. Yantic River, Connecticut.
 39 B. Quinebaug River, Connecticut.
 39 C. Shetucket River, Connecticut.
 39 D. Little River, Connecticut.
 39 E. Natchaug River, Connecticut.
 39 F. Fenton River, Connecticut.

39. Thames River, Connecticut—Continued.
- 39 G. Mount Hope River, Connecticut.
- 39 H. Bigelow River, Connecticut.
- 39 J. Still River, Connecticut.
- 39 K. Hop River, Connecticut.
- 39 L. Willimantic River, Connecticut.
- 39 M. French River, Connecticut and Massachusetts.
- 39 N. Five-Mile River, Connecticut.
- 39 O. Moosup River, Connecticut and Rhode Island.
- 39 P. Bigelow Branch, Connecticut.
- 39 Q. Roaring Brook, Connecticut.

40. Niantic River, Connecticut.

41. Connecticut River, Connecticut.
- 41 *a*. Salmon River, Connecticut.
- 41 *b*. Park River, Connecticut.
  - 41 *c*. North Branch of Park River, Connecticut.
  - 41 *d*. South Branch of Park River, Connecticut.
- 41 *e*. Pedank River, Connecticut.
- 41 *f*. Meadow Creek, Connecticut.
- 41 A. Farmington River, Connecticut and Massachusetts.
  - 41 A *a*. Paquabuck River, Connecticut.
  - 41 B. Hubbard's River, Massachusetts.
  - 41 B *a*. West Branch of Farmington River, Connecticut.
  - 41 B *b*. Still River, Connecticut.
- 41 C. Scantic River, Massachusetts.
- 41 C *a*. Agawam River, Massachusetts.
- 41 D. Westfield River, Massachusetts.
  - 41 E. Little River, Massachusetts.
- 41 F. Middle Branch of Westfield River, Massachusetts.
- 41 G. Chicopee River, Massachusetts.
  - 41 H. Jobbish River, Massachusetts.
  - 41 J. Swift River, Massachusetts.
  - 41 K. Ware River, Massachusetts.
    - 41 L. Burn Shirt River, Massachusetts.
- 41 M. Stony Branch, Massachusetts.
- 41 N. Bachelor's Branch, Massachusetts.
- 41 O. Manham River, Massachusetts.
- 41 P. Fort River, Massachusetts.
- 41 Q. Deerfield River, Massachusetts.
  - 41 R. Green River, Massachusetts.
  - 41 S. South River, Massachusetts.
  - 41 T. Bear River, Massachusetts.
  - 41 U. North River, Massachusetts.
  - 41 V. Cold River, Massachusetts.
- 41 W. Miller's River, Massachusetts.
  - 41 X. Tilly River, Massachusetts.

41. Connecticut River, Connecticut—Continued.
 41 Y. White River, Vermont.
 41 Z. Dog River, Vermont.
 41 A2. Moose River, Vermont.
 41 B2. Philip's River, New Hampshire.
 41 C2. Diamond River, New Hampshire.
 41 D2. Indian Stream, New Hampshire.
42. Poultney River, Vermont and New York.
43. New Haven River, Vermont.
44. Winooski River, Vermont.
 44 A. Mud River, Vermont.
45. Monunnetsuc River, Connecticut.
46. Hammonassett River, Connecticut.
46 *a*. Quinipiac River, Connecticut.
47. Housatonic River, Connecticut and Massachusetts.
 47 A. Farmill River, Connecticut.
 47 B. Naugatuck River, Connecticut.
 47 C. Quasapaug River, Connecticut.
 47 D. Eight-mile Branch, Connecticut.
 47 E. Pomeraug River, Connecticut.
 47 F. Shepaug River, Connecticut.
 47 G. Still River, Connecticut.
 47 H. Mill River, Massachusetts.
 47 J. Hop Branch, Massachusetts.
48. Pequannock River, Connecticut.
49. Mill River, Connecticut.
50. Saugatuck River, Connecticut.
51. Norwalk River, Connecticut.
51¼. Ripowam River, Connecticut.
51½. Mianus River, Connecticut.
51¾. Bryam River, Connecticut.
52. Hudson River, New York.
 52 A. East River, New York.
 52 B. Harlem River, New York.
 52 C. Croton River, New York.
 52 D. Wallkill River, New York and New Jersey.
 52 E. Catskill Creek, New York.
 52 F. Mohawk River, New York.
 52 G. Schoharie Creek, New York.
 52 H. Canada Creek, New York.
 52 J. West Canada Creek, New York.
 52 K. Hoosac River, New York.
 52 L. Green River, New York.
 52 M. Sacondaga River, New York.
 52 N. Schrook River and Lake, New York
 52 O. Indian River and Lake, New York.

52. Hudson River, New York—Continued.
    52 P. Jessup's River, New York.
    52 Q. Cedar River, New York.
53. Pawley River, New York.
54. Bouquet River, New York.
55. Au Sable River, New York.
    55 A. East Branch of Au Sable River, New York.
    55 B. West Branch of Au Sable River, New York.
56. Saranac River, New York.
57. Delaware River, New York.
58. Cold River, New York.
59. Passaic River, New Jersey.
    59 A. Ramapo River, New Jersey.
60. Rahway River, New Jersey.
61. Raritan River, New Jersey.
    61 A. South River, New Jersey.
    61 B. Dead River, New Jersey.
    61 C. Millstone River, New Jersey.
    61 E. North Branch of Raritan River, New Jersey.
    61 F. South Branch of Raritan River, New Jersey.
62. Navesink River, New Jersey.
63. Shark River, New Jersey.
64. Manisquan River, New Jersey.
65. Metedeconk River, New Jersey.
66. Tom's River, New Jersey.
    66 A. Ridgeway Branch of Tom's River, New Jersey.
    67 A. Bass River, New Jersey.
    67 B. Wading River, New Jersey.
    67 C. Oswego River, New Jersey.
    67 D. East Branch of Wading River, New Jersey.
    67 E. West Branch of Wading River, New Jersey.
    67 F. Batsto River, New Jersey.
    67 G. Atsion River, New Jersey.
68. Great Egg Harbor River, New Jersey.
69. Tuckahoe River, New Jersey.
70. Delaware Bay, Delaware.
    70 A. Indian River, Delaware.
    70 B. Mispillion River, Delaware.
    70 C. Maurice River, New Jersey.
    70 D. DELAWARE RIVER, Delaware and New Jersey, *vide* 71.
71. Delaware River, Delaware, New Jersey, Pennsylvania, and New York.
    71 A. Cohansey River, New Jersey.
    71 B. Salem River, New Jersey.
    71 C. Christiana River, Delaware.
    71 D. Brandywine River, Delaware.

71. Delaware River, &c.—Continued.
- 71 E. Chester River, Pennsylvania.
- 71 F. Schuylkill River, Pennsylvania.
- 71 G. Musconetcong River, New Jersey.
- 71 H. Lehigh River, Pennsylvania.
- 71 J. Pequest River, New Jersey.
- 71 K. Flat Brook River, New Jersey.
- 71 L. Neversink River, New York.
- 71 M. Lackawaxen River, Pennsylvania.
- 71 N. Delaware River, East Branch of, New York.
- 71 O. Delaware River, West Branch of, New York.

72. Chesapeake Bay, Maryland.
- 72 A. Pocomoke River, East Shore of Maryland and Virginia.
- 72 B. Nascongo River, Maryland, East Shore Chesapeake Bay.
- 72 C. Manokin River, Maryland, East Shore Chesapeake Bay.
- 72 D. Wicomico River, Maryland, Tangiers Sound.
- 72 E. Nanticoke River, Maryland, East Shore Chesapeake Bay.
- 72 F. Quantico River, Maryland, East Shore Chesapeake Bay.
- 72 G. Transquaking River, Maryland, Fishing Bay.
- 72 H. Chicacomico River, Maryland, East Shore Chesapeake Bay.
- 72 J. Houga River, Maryland, East Shore Chesapeake Bay.
- 72 K. Hudons River, Maryland, East Shore Chesapeake Bay.
- 72 L. Choptank River, Maryland, East Shore Chesapeake Bay.
- 72 M. Wye River, Maryland, East Shore Chesapeake Bay.
- 72 N. Chester River, Maryland, East Shore Chesapeake Bay.
- 72 O. Sassafras River, Maryland, East Shore Chesapeake Bay.
- 72 P. Elk River, Maryland, East Shore Chesapeake Bay.
- 72 Q. Northeast River, Maryland, East Shore Chesapeake Bay.
- 72 R. SUSQUEHANNA RIVER, Maryland, Pennsylvania, and New York, *vide* 73.
- 72 S. Bush River, Maryland, West Shore Chesapeake Bay.
- 72 T. Big Gunpowder River, Maryland, West Shore Chesapeake Bay.
- 72 U. Little Gunpowder River, Maryland, West Shore Chesapeake Bay.
- 72 V. Middle River, Maryland, West Shore Chesapeake Bay.
- 72 W. Patapsco River, Maryland, West Shore Chesapeake Bay.
- 72 X. Magothy River, Maryland, West Shore Chesapeake Bay.
- 72 Z. South River, Maryland, West Shore Chesapeake Bay.
- 72 A2. West River, Maryland, West Shore Chesapeake Bay.
- 72 B2. Patuxent River, Maryland, West Shore Chesapeake Bay.
- 72 C2. POTOMAC RIVER, Maryland and Virginia, West Shore Chesapeake Bay, *vide* 74.

72. Chesapeake Bay, Maryland—Continued.
   - 72 D2. RAPPAHANNOCK RIVER, Virginia, West Shore Chesapeake Bay, *vide* 75.
   - 72 E2. Piankatank River, Virginia.
   - 72 F2. MOBJACK BAY, Virginia, *vide* 76.
   - 72 G2. YORK RIVER, Virginia, *vide* 77.
   - 72 H2. JAMES RIVER, Virginia, *vide* 78.

73. Susquehanna River, Maryland, Pennsylvania, and New York.
   - 73 A. Juniata River, Pennsylvania.
     - 73 B. Tuscarora Creek, Pennsylvania.
     - 73 C. Rayston Branch, Pennsylvania.
   - 73 D. North Branch of Susquehanna, Pennsylvania.
   - 73 E. West Branch of Susquehanna, Pennsylvania.
     - 73 F. Lycoming Creek, Pennsylvania.
     - 73 G. Roaring River, Pennsylvania.
   - 73 H. East Branch of Susquehanna, Pennsylvania.
     - 73 J. Sinnemahong Creek, Pennsylvania.
   - 73 K. Chemung River, Pennsylvania.
     - 73 L. Conhocton River, New York.
     - 73 M. Canisteo River, New York.
     - 73 N. Cowanestue River, Pennsylvania.
     - 73 O. Tioga River, Pennsylvania.
   - 73 P. Chenango River, Pennsylvania.

74. Potomac River, Virginia.
   - 74 A. St. Mary's River, Maryland.
   - 74 B. Wicomico River, Maryland.
   - 74 C. Mattawoman River, Maryland.
   - 74 D. Tobacco River, Maryland.
   - 74 E. Piscataway River, Maryland.
   - 74 F. Monocacy River, Maryland.
   - 74 G. Antietam River, Maryland.
   - 74 H. Conecocheague River, Maryland.
   - 74 J. Shenandoah River, Virginia.
     - 74 K. North Fork of Shenandoah River, Virginia.
     - 74 L. South Fork of Shenandoah River, Virginia.
       - 74 M. North River, Virginia.
       - 74 N. Middle River, Virginia.
       - 74 O. South River, Virginia.
   - 74 P. Opequan Creek, Virginia.
   - 74 Q. Back Creek, Virginia.
   - 74 R. Meadow Branch, Virginia.
   - 74 S. Sleepy Creek, Virginia.
   - 74 T. Cacapon River, Virginia.
     - 74 U. North River, Virginia.
     - 74 V. Lost River, Virginia.
   - 74 W. Occoquan River, Virginia.

74. Potomac River, Virginia—Continued.
  74 X. Aquia Creek, Virginia.
  74 Y. Nomini River, Virginia.
75. Rappahannock River, Virginia.
  75 A. North Fork of Rappahannock, Virginia.
  75 B. Aestham River, Virginia.
  75 C. Hazel River, Virginia.
  75 D. Battle River, Virginia.
  75 E. Hedgeman River, Virginia.
  75 G. Great River, Virginia.
  75 H. Curtis River, Virginia.
  75 J. Thumo River, Virginia.
  75 K. White Oak River, Virginia.
  75 L. Hungry River, Virginia.
  75 M. Jordan's River, Virginia.
  75 N. Buck River, Virginia.
  75 O. Rapidan River, Virginia.
  75 P. Hunting River, Virginia.
  75 Q. Middle River, Virginia.
  75 R. Hazel River, Virginia.
  75 S. Flat River, Virginia.
  75 T. Thompson River, Virginia.
  75 U. Russell River, Virginia.
  75 V. Fleshman's River, Virginia.
  75 W. Brook's River, Virginia.
  75 X. Black Walnut River, Virginia.
  75 Y. Mountain River, Virginia.
  75 Z. Potato River, Virginia.
  75 A2. Summer Duck River, Virginia.
  75 B2. Cedar River, Virginia.
  75 C2. Crooked River, Virginia.
  75 D2. Robinson's River, Virginia.
  75 E2. Great River, Virginia.
  75 F2. Baylor's River, Virginia.
  75 G2. Beautiful River, Virginia.
  75 H2. Blue River, Virginia.
  75 J2. Mush River, Virginia.
  75 K2. Ahorts River, Virginia.
  75 L2. Rippin's River, Virginia.
  75 M2. Elk River, Virginia.
  75 N2. Ballard's River, Virginia.
  75 O2. Conway River, Virginia.
  75 P2. Staunton River, Virginia.
76. Mobjack Bay, Virginia.
  76 A. East River, Virginia.
  76 B. North River, Virginia.

76. Mobjack Bay, Virginia—Continued.
    76 C. Ware River, Virginia.
    76 D. Severn River, Virginia.
77. York River, Virginia.
    77 A. Mattapony River, Virginia.
    77 B. Mat River, Virginia.
    77 C. Ta River, Virginia.
    77 D. Po River, Virginia.
    77 E. Ny River, Virginia.
    77 F. Pamunkey River, Virginia.
    77 G. North Anna River, Virginia.
    77 H. South Anna River, Virginia.
78. James River, Virginia.
    78 A. Chickahominy River, Virginia.
    78 B. Appomattox River, Virginia.
    78 C. Rivanna River, Virginia.
    78 D. Hardware River, Virginia.
    78 E. Rock Creek, Virginia.
    78 F. Tye River, Virginia.
    78 G. Pedlar River, Virginia.
    78 H. North Branch of James River, Virginia.
    78 J. South Branch of James River, Virginia.
    78 K. Cow Pasture River, Virginia.
    78 L. Jackson's River, Virginia.
79. Elizabeth River, Virginia.
80. Albemarle Sound, North Carolina.
    80 A. North River, North Carolina.
    80 B. Pasquotank River, North Carolina.
    80 C. Alligator River, North Carolina.
    80 D. Chowan River, North Carolina.
    80 E. Nottoway River, North Carolina.
    80 F. Blackwater River, Virginia.
    80 G. Little Nottoway River, Virginia.
    80 H. Meherrin River, North Carolina.
    80 J. North Meherrin River, Virginia.
    80 K. Middle Meherrin River, Virginia.
    80 L. South Meherrin River, Virginia.
    80 M. Roanoke River, North Carolina.
    80 N. Dan River, Virginia.
    80 O. Hy-co-tee River, Virginia.
    80 P. Banister River, Virginia.
    80 Q. Smith's River, North Carolina.
    80 R. Mayo River, North Carolina.
    80 S. Town Fork of Roanoke River, North Carolina.
    80 T. Little Dan River, North Carolina.

80. Albemarle Sound, North Carolina—Continued.
- 80 U. Staunton River, Virginia.
- 80 V. Little Roanoke River, Virginia.
- 80 W. Falling River, Virginia.
- 80 X. Otter River, Virginia.
- 80 Y. Pig River, Virginia.
- 80 Z. Blackwater River, Virginia.
- 80 A2. Roanoke River, Virginia.

81. Pamlico Sound, North Carolina.
- 81 A. Pungo River, North Carolina.
- 81 B. Pamlico River, North Carolina.
- 81 C. Tar River, North Carolina.
- 81 D. Bay River, North Carolina.
- 81 E. Neuse River, North Carolina.
- 81 F. Trent River, North Carolina.
- 81 G. White Oak River, North Carolina.

82. Cape Fear River, North Carolina.
- 82 A. Northeast Cape Fear River, North Carolina.
- 82 B. South River, North Carolina.
- 82 C. Deep River, North Carolina.
- 82 D. Black River, North Carolina.
- 82 E. Haw River, North Carolina.
- 82 F. Logwood Folly River, North Carolina.

83. Great Pedee River, South Carolina and North Carolina.
- 83 A Waccamaw River, South Carolina.
- 83 B. Little Pedee River, South Carolina.
- 83 C. Lumber River, South Carolina.
- 83 D. Little Creek, North Carolina.
- 83 E. Rocky River, North Carolina.
- 83 F. Long Creek, North Carolina.
- 83 G. Island Creek, North Carolina.
- 83 H. Dutch Buffalo Creek, North Carolina.
- 83 J. Cold Water Creek, North Carolina.
- 83 K. Irish Buffalo Creek, North Carolina.
- 83 L. Coddle Creek, North Carolina.
- 83 M. Yadkin River, North Carolina.
- 83 N. Uharee River, North Carolina.
- 83 O. Cabin Creek, North Carolina.
- 83 P. Abbott's Creek, North Carolina.
- 83 Q. Swearing Creek, North Carolina.
- 83 R. Grant's Creek, North Carolina.
- 83 S. South Yadkin River, North Carolina.
- 83 T. Second Creek, North Carolina.
- 83 U. Third Creek, North Carolina.
- 83 V. Fourth Creek, North Carolina.
- 83 W. Hunting Creek, North Carolina.

83. Great Pedee River, North Carolina and South Carolina—Cont'd.
  83 X. Fifth Creek, North Carolina.
  83 Y. Rocky Creek, North Carolina.
  83 Z. Snow Creek, North Carolina.
  83 A2. Dutchman's Creek, North Carolina.
  83 B2. Walsen Creek, North Carolina.
  83 C2. Muddy Creek, North Carolina.
  83 D2. South Deep Creek, North Carolina.
  83 E2. North Deep Creek, North Carolina.
  83 F2. Ararat Creek, North Carolina.
  83 G2. Fisher's Creek, North Carolina.
84. Black River, South Carolina.
85. Winyah River, South Carolina.
86. Santee River, South Carolina.
  86 A. North Santee River, South Carolina.
  86 B. South Santee River, South Carolina.
  86 C. Wateree River, South Carolina.
  86 D. Catawba River, North Carolina.
  86 E. Crowder's Creek, North Carolina.
  86 F. South Fork of Catawba, North Carolina.
  86 G. Clark's Creek, North Carolina.
  86 H. Pott's Creek, North Carolina.
  86 J. Jacob's Fork, North Carolina.
  86 K. Dutchman's Creek, North Carolina.
  86 L. Snyder's Creek, North Carolina.
  86 M. Lower Little River, North Carolina.
  86 N. Lower Creek, North Carolina.
  86 O. John's River, North Carolina.
  86 P. Upper Creek, North Carolina.
  86 Q. Silver Creek, North Carolina.
  86 R. Linville River, North Carolina.
  86 S. Muddy Creek, North Carolina.
  86 T. North Fork, North Carolina.
  86 U. Congaree River, South Carolina.
  86 V. Broad River, South Carolina.
  86 W. Enoree River, South Carolina.
  86 X. Pacolet River, South Carolina.
  86 Y. Buffalo Creek, North and South Carolina.
  86 Z. First Broad River, North Carolina.
  86 A2. Cane Creek, North Carolina.
  86 B2. Green River, North Carolina.
  86 C2. Saluda River, South Carolina.
87. Cooper River, South Carolina.
88. Ashley River, South Carolina.
89. Edisto River, South Carolina.
  89 A. North Edisto River, South Carolina.
  89 B. South Edisto River, South Carolina.

90. Combahee River, South Carolina.
91. Coosawhatchie River, South Carolina.
92. Broad River, South Carolina.
93. Savannah River, Georgia and South Carolina.
   93 A. Ebenezer Creek, Georgia.
   93 B. Brier Creek, Georgia.
   93 C. Beaverdam Creek, Georgia.
   93 D. McLean Creek, Georgia.
   93 E. Soap Creek, Georgia.
   93 F. Fishing Creek, Georgia.
   93 G. Little River, South Carolina.
   93 H. Diamond Fork, Georgia
   93 J. Rocky River, South Carolina.
   93 K. Keowee River, South Carolina.
   93 L. Hard Labor Creek, South Carolina.
   93 M. Broad River, Georgia
   93 N. Lang Creek, Georgia.
   93 O. South Fork, Georgia.
   93 P. Webb's Creek, Georgia.
   93 Q. Bushy Creek Fork, Georgia.
   93 R. North Fork, Georgia.
   93 S. Beaverdam Creek, Georgia.
   93 T. Coldwater Creek, Georgia.
   93 U. Tallulah River, Georgia.
   93 V. Chatuga River, Georgia.
   93 W. Tugaloo River, Georgia.
94. Ogeechee River, Georgia.
   94 A. Cannouchee River, Georgia.
   94 A *a*. Little Cannouchee River, Georgia.
   94 B. Big and Little Lott's Creek, Georgia.
   94 B *a*. Bull Creek, Georgia.
   94 C. Cedar Creek, Georgia.
   94 D. Ten-Mile Creek, Georgia.
   94 E. Dry Creek, Georgia.
   94 F. Hound Creek, Georgia.
   94 G. Jack's Creek, Georgia.
   94 H. Fifteen-Mile Creek, Georgia.
   94 J. Bird's Mill Creek, Georgia.
   94 K. Malden Branch, Georgia.
   94 L. Little Ogeechee River, Georgia.
   94 M. Nevils Creek, Georgia.
   94 N. Buckhead Creek, Georgia.
   94 O. Rocky Creek, Georgia.
   94 P. Williamson's Swamp Creek, Georgia
   94 Q. Rocky Creek, Georgia.
   94 R. Big Creek, Georgia.

94. Ogeechee River, Georgia—Continued.
  94 S. Rocky Comfort Creek, Georgia.
  94 T. Scull's Creek, Georgia.
  94 U. Medway River, Georgia.
95. North Newport River, Georgia.
96. South Newport River, Georgia.
97. Sapelo River, Georgia.
98. Altamaha River, Georgia.
  98 A. Jones Creek, Georgia.
  98 B. Beard's Creek, Georgia.
  98 C. Great Ohoopee River, Georgia.
  98 D. Little Ohoopee River, Georgia.
  98 E. Pendleton Creek, Georgia.
  98 F. Rocky Creek, Georgia.
  98 G. Oconee River, Georgia.
  98 H. Okeewatkee Creek, Georgia.
  98 J. Turkey Creek, Georgia.
  98 K. Red Bluff Creek, Georgia.
  98 L. Bluff Creek, Georgia.
  98 M. Big Sandy Creek, Georgia.
  98 N. Commissioner Creek, Georgia.
  98 O. Buffalo Creek, Georgia.
  98 P. Murder Creek, Georgia.
  98 Q. Little River, Georgia.
  98 R. Indian Creek, Georgia.
  98 S. Appalachee River, Georgia.
  98 T. North Fork of Appalachee, Georgia.
  98 U. Middle Oconee River, Georgia.
  98 V. Beech Creek, Georgia.
  98 W. North Oconee River, Georgia.
  98 A2. Ocmulgee River, Georgia.
  98 B2. Little Ocmulgee River, Georgia.
  98 C2. Swamp Creek, Georgia.
  98 D2. North Fork of Swamp Creek, Georgia.
  98 E2. Salem Creek, Georgia.
  98 F2. Sugar Creek, Georgia.
  98 G2. Cedar Creek, Georgia.
  98 H2. House Creek, Georgia.
  98 J2. Cedar Creek, Georgia.
  98 K2. Bluff Creek, Georgia.
  98 L2. Mosquito Creek, Georgia.
  98 M2. Tuscawhatchee Creek, Georgia.
  98 N2. Indian Creek, Georgia.
  98 O2. Mossy Creek, Georgia.
  98 P2. Echaconnee Creek, Georgia.
  98 Q2. Echacopee Creek, Georgia.

98. Altamoha River, Georgia—Continued.
- 98 R2. Tobesotkee Creek, Georgia.
- 98 S2. Rum Creek, Georgia.
- 98 T2. Towaliga Creek, Georgia.
- 98 U2. Tussehaw Creek, Georgia.
- 99 V2. South River, Georgia.
- 98 W2. Walnut Creek, Georgia.
- 98 X2. Yellow River, Georgia.
- 98 Y2. Ulcofauhachee River, Georgia.
- 98 Z2. Willow River, Georgia.

99. Little Satilla River, Georgia.

100. Satilla River, Georgia.
- 100 A. White Oak Creek, Georgia.
- 100 B. Buffalo Creek, Georgia.
- 100 C. Little Satilla River, Georgia.
- 100 D. Saint Illa Creek, Georgia.
- 100 E. Dry Creek, Georgia.
- 100 F. Hog Creek, Georgia.
- 100 G. Seventeen-Mile Creek, Georgia.
- 100 H. Big Hurricane Creek, Georgia.
- 100 J. Little Hurricane Creek, Georgia.
- 100 K. Red Bluff Creek, Georgia.
- 100 L. Crooked River, Georgia.

101. Saint Mary's River, Florida and Georgia.
- 101 A. North Fork of Saint Mary's, Florida.
- 101 B. Cedar Creek, Florida.
- 101 C. West Branch of Saint Mary's, Florida.

102. Saint John's River, Florida.
- 102 A. Etonia River, Florida.
- 102 B. Dunn's Lake, Florida.
- 102 C. Haw Creek, Florida.
- 102 D. Oklawaha River, Florida.
- 102 E. Lake George, Florida.
- 102 F. Juniper Creek, Florida.
- 102 G. Lake Monroe, Florida.
- 102 H. Lake Harney, Florida.
- 102 J. Lake Washington, Florida.
- 102 K. Orange Lake, Florida.
- 102 L. Lake Griffin, Florida.
- 102 M. Lake Eustace, Florida.
- 102 N. Lake Hawkins, Florida.
- 102 O. Sams Lake, Florida.
- 102 P. Lake Ahapopka, Florida.
- 102 Q. Hawk Creek, Florida.

103. Halifax River, Florida.
- 103 A. Lake Ashby, Florida.

104. Indian River, Florida.
    104 A. Lake Poinsett, Florida.
    104 B. Saint Sebastian Creek, Florida.
    104 C. Lucie River, Florida.
105. Harney's River, Florida.
106. Roger's River, Florida.
107. Chittohatchee River, Florida.
108. Fahkahnatche River, Florida.
109. Gallivans River, Florida.
110. Caloosahatchie River, Florida.
    110 A. Lake Okeechobee, Florida.
    110 B. Lake Kickpochee, Florida.
    110 C. Kissimmee River, Florida.
    110 D. Lakes Istokpoga, Crane, Clay, Childs, and Stearns.
    110 E. Lake Kissimmee, Florida.
    110 F. Lake Cypress, Florida.
    110 G. Lake Marian, Florida.
    110 H. Reedy Creek, Florida.
    110 J. Lake Whopekaliga, Florida.
111. Peace River, Florida.
    111 A. Big Charlie Aopoka Creek, Florida.
    111 B. Lake Livingston, Florida.
    111 C. Bowley's Creek, Florida.
    111 D. Hancock Lake, Florida.
112. Myakka River, Florida.
113. Manatee River, Florida.
114. Little Manatee River, Florida.
115. Allafia River, Florida.
116. Lockapopka River, Florida.
    116 A. Lake Ahapopka, Florida.
117. Anclote River, Florida.
118. Echaskotee River, Florida.
119. Chessehowiska River, Florida.
120. Homosassa River, Florida.
121. Crystal River, Florida.
122. Withlacoochee River, Florida.
123. Suwannee River, Florida.
    123 A. Santa Fe River, Florida.
    123 B. North River, Florida.
    123 C. Santa Fe Lake, Florida.
    123 *Ca.* Ty Ty Creek, Georgia.
    123 *Cb.* Indian Creek, Georgia.
    123 *Cc.* Warrior Creek, Georgia.
    123 D. Withcacoochee River, Georgia.
    123 *Da.* Piscola Creek, Georgia.

123. Suwannee River, Florida—Continued.
- 123 E. Ocopilco Creek, Georgia.
- 123 F. Little River, Georgia.
- 123 G. New River, Georgia.
- 123 H. Allapaha River, Georgia.
- 123 J. Lake Creek, Georgia.
- 123 K. Suwanoochee Creek, Georgia.
- 123 L. East Suwanoochee Creek, Georgia.
- 123 M. Jones Creek, Georgia.
- 123 N. Toms Creek, Georgia.
- 123 O. Deer Creek, Georgia.
- 123 P. Long Creek, Georgia.

124. Warrior River, Florida.
125. Finholloway River, Florida.
126. Econfina River, Florida.
127. Ocilla River, Florida.
128. Saint Mark's River, Florida.
- 128 A. Miccosukee Lake, Florida.

129. Ocklockonee River, Florida and Georgia.
- 129 A. Taluga River, Florida.
- 129 B. Lake Iamona, Florida.
- 129 C. Toms Creek, Georgia.
- 129 D. Walden's Creek, Georgia.
- 129 E. Swamp Creek, Florida and Georgia.
- 129 F. Barnetts Creek, Georgia.
- 129 G. Turkey Creek, Georgia.
- 129 H. Bridge Creek, Georgia.

130. Appalachicola River, Florida and Georgia.
- 130 A. Harris Lake, Florida.
- 130 B. Chipola River and Lake, Florida.
- 130 C. Blue Creek, Florida.
- 130 D. Flint River, Georgia.
- 130 E. Spring Creek, Georgia.
- 130 F. Ichaway-nochaway Creek, Georgia.
- 130 G. Kiokee Creek, Georgia.
- 130 H. Puchitla Creek, Georgia.
- 130 J. Abrams Creek, Georgia.
- 130 K. Lampkins Creek, Georgia.
- 130 L. Whitewater Creek, Georgia.
- 130 M. Cedar Creek, Georgia.
- 130 N. Big Potato Creek, Georgia.
- 130 O. Lazer Creek, Georgia.
- 130 P. Red Oak Creek, Georgia.
- 130 Q. Line Creek, Georgia.
- 130 R. Acocks Creek, Georgia.
- 130 S. Cooteewa Creek, Georgia.

130. Appalachicola River, Florida and Georgia—Continued.
- 130 T. Kinahafonee Creek, Georgia.
- 130 U. Mulkalee Creek, Georgia.
- 130 V. Bear Creek, Georgia.
- 130 W. Chattahoochee River, Alabama and Georgia.
- 130 X. Cowikee Creek, Alabama.
- 130 Y. Pataula Creek, Georgia.
- 130 Z. Upatoi Creek, Georgia.
- 130 A2. Uchee Creek, Alabama.
- 130 B2. Big Uchee Creek, Alabama.
- 130 C2. Mulberry Creek, Georgia.
- 130 D2. Long Creek, Georgia.
- 130 E2. Yellow Jacket Creek, Georgia.
- 130 F2. Hodchodkee Creek, Georgia.
- 130 G2. Hannahatchee Creek, Georgia.
- 130 H2. Mountain Creek, Georgia.
- 130 J2. Wetumpka Creek, Alabama.
- 130 K2. Flat Shoal Creek, Georgia.
- 130 L2. Wehatchee Creek, Georgia.
- 130 M2. Sweetwater Creek, Georgia.
- 130 N2. Chastatee River, Georgia.
- 130 O2. Soquac Creek, Georgia.

131. St. Andrew's Bay, Florida.
- 131 A. North Arm of St. Andrew's Bay, Florida.
- 131 B. Bear Creek, Florida.
- 131 C. Econfina Creek, Florida.

132. Choctawhatchee River, Florida.
- 132 A. Pine Log Creek, Florida.
- 132 B. Holmes Creek, Florida.
- 132 C. Pea River, Florida and Alabama.
- 132 D. Parrot Creek, Florida.
- 132 E. West Branch of Choctawhatchee River, Florida.
- 132 F. East Branch of Choctawhatchee River, Alabama.

133. Choctawhatchee Bay, Florida.
- 133 A. Clear Creek, Florida.
- 133 B. Alaqua Creek, Florida.
- 133 C. Rock Creek, Florida.
- 133 D. Juniper Creek, Florida.

134. East Bay, Florida.
- 134 A. East Bay River, Florida.
- 134 B. Yellow River, Florida.
- 134 C. Shoal River, Florida.
- 134 D. East Branch of Blackwater, Florida.
- 134 E. West Branch of Blackwater, Florida.
- 134 F. Clear Water River, Florida.

135. Escambia River, Florida.
    - 135 A. Conecuh River, Alabama.
        - 135 A*a*. Murder Creek, Alabama.
        - 135 B. Burnt Corn Creek, Alabama.
    - 135 C. Sepulgah River, Alabama.
        - 135 D. Long Creek, Alabama.
    - 135 E. Patsaliga River, Alabama.

136. Perdido River, Florida and Alabama.
    - 136 A. Blackwater Creek, Alabama.
    - 136 B. Hollingers Creek, Alabama.

137. North Branch of Fish River, Alabama.

138. East Branch of Fish River, Alabama.

139. Kensaw River, Alabama.

140. Mobile River, Alabama.
    - 140 A. Chickasaw Creek, Alabama.
    - 140 B. Alabama River, Alabama.
        - 140 C. Coffee Bayou, Alabama.
        - 140 D. Marmotte Bayou, Alabama.
        - 140 E. Chetauge Bayou, Alabama.
        - 140 F. Little River, Alabama.
        - 140 G. Randoms Creek, Alabama.
        - 140 H. Limestone Creek, Alabama..
        - 140 J. Flat Creek, Alabama.
        - 140 K. Bear Creek, Alabama.
        - 140 L. Pursley Creek, Alabama.
        - 140 M. Bogue Chitto, Alabama.
        - 140 N. Beaver Creek, Alabama.
        - 140 O. Clatchee Creek, Alabama.
        - 140 P. Pine Barren Creek, Alabama.
        - 140 Q. Cedar Creek, Alabama.
            - 140 R. Mush Creek, Alabama.
        - 140 S. Cahawba River, Alabama.
            - 140 T. Shades Creek, Alabama.
            - 140 U. Oakmulgee Creek, Alabama.
        - 140 V. Little Cahawba River, Alabama.
        - 140 W. Mulberry Creek, Alabama.
        - 140 X. Little Mulberry Creek, Alabama.
        - 140 Y. Big Swamp Creek, Alabama.
        - 140 Z. Swift Creek, Alabama.
        - 140 A2. Manacks Creek, Alabama.
        - 140 B2. Catawa Creek, Alabama.
        - 140 C2. Coosa River, Alabama.
            - 140 D2. Chestnut Creek, Alabama.
            - 140 E2. Weogufka Creek, Alabama.
            - 140 F2. Kellys Creek, Alabama.
            - 140 G2. Chokolocho Creek, Alabama.

140. Mobile River, Alabama—Contnued.

140 H2. Cane Creek, Alabama.
140 J2. Obatchee Creek, Alabama.
140 K2. Canoe Creek, Alabama.
140 L2. Wilds Creek, Alabama.
140 M2. Terrapin Creek, Alabama.
140 N2. Hatchee Creek, Alabama.
140 O2. Talladega Creek, Alabama.
140 P2. Clear Creek, Alabama.
140 Q2. Chattooga River, Alabama and Georgia.
140 R2. Etowah River, Georgia.
140 S2. Conasodga River, Georgia.
140 T2. Coosawattee River, Georgia.
140 U2. Oostanagata River, Georgia.
140 V2. Tallapoosa River, Alabama and Georgia.
140 W2. Oldtown Creek, Alabama.
140 X2. Oakfuskee, Creek, Alabama.
140 Y2. Cupiahatchee Creek, Alabama.
140 Z2. Killchee Creek, Alabama.
140 A3. Hillabeellatchie Creek, Alabama.
140 B3. Condutchkee Creek, Alabama.
140 C3. Callabee Creek, Alabama.
140 D3. Ufoupee Creek, Alabama.
140 E3. Buckahatchee Creek, Alabama.
140 F3. Blue Creek, Alabama.
140 G3. Sand Creek, Alabama.
140 H3. Fox Creek, Alabama.
140 J3. Fox Creek, Alabama.
140 K3. Little Tallapoosa River, Alabama and Georgia.
140 L3. Tombigbee River, Alabama.
140 M3. Poll Bayou, Alabama.
140 N3. Bates Creek, Alabama.
140 O3. Johnson's Creek, Alabama.
140 P3. Okanoxubee River, Alabama.
140 Q3. Bodca Creek, Alabama.
140 R3. Barret's Creek, Alabama.
140 S3. Jackson's Creek, Alabama.
140 T3. Sinla Bogue Creek, Alabama.
140 U3. Satilpa Creek, Alabama.
140 V3. Okatappa Creek, Alabama.
140 W3. Bear Creek, Alabama.
140 X3. Bashi Creek, Alabama.
140 Y3. Horse Creek, Alabama.
140 Z3. Tickabum Creek, Alabama.
140 A4. Beaver Creek, Alabama.

140. Mobile River, Alabama—Continued.

140 B4. Chickasaw Bogue Creek, Alabama.
140 C4. Alamutchee Creek, Alabama.
140 D4. Sucranochee Creek, Alabama.
140 E4. Black Warrior River, Alabama.
140 F4. Big Prairie Creek, Alabama.
140 G4. Big Creek, Alabama.
140 H4. Five-Mile Creek, Alabama.
140 J4. Big Sandy Creek, Alabama.
140 K4. North River, Alabama.
140 L4. Davis Creek, Alabama.
140 M4. Yellow Creek, Alabama.
140 N4. Valley Creek, Alabama.
140 O4. Locust Fork of Black Warrior River, Alabama.
140 P4. Five-Mile Creek, Alabama.
140 Q4. Lost Creek, Alabama.
140 R4. Mulberry Fork, Alabama.
140 S4. Black Warrior Creek, Alabama:
140 W4. Village Creek, Alabama.
140 X4. Blackwater Creek, Alabama.
140 Y4. Sipsey Creek, Alabama.
140 Z4. East Fork of Black Warrior, Alabama.
140 A5. Little Tombigbee River, Alabama and Mississippi.
140 B5. Sipsey River, Alabama.
140 C5. Lubbub Creek, Alabama.
140 D5. Coal Fire Creek, Alabama.
140 E5. Looxapalila River, Mississippi and Albama.
140 E5*a*. Tibbee Creek, Mississippi.
140 F5. Lime Creek, Mississippi.
140 G5. Buttahatchie River, Mississippi and Alabama.
140 H5. West Fork of Buttahatchie River, Mississippi and Alabama.
140 J5. Weaver Creek, Mississippi.
140 K5. East Fork of Tombigbee, Mississippi.
140 L5. West Fork of Tombigbee, Mississippi.
140 M5. Chatibbewich Creek, Mississippi.
140 N5. Chowwappa Creek, Mississippi.
140 O5. Fowl River, Alabama.
140 P5. Town Creek, Alabama.
140 Q5. Gum Creek, Alabama.

141. Escatawpa River, Mississippi and Alabama.

142. Pascagoula River, Mississippi.
  142 A. Red Creek, Mississippi.
  142 B. Bluff Creek, Mississippi.
  142 C. Black Creek, Mississippi.
  142 D. Beaver Creek, Mississippi.
  142 E. Leaf River, Mississippi.
  142 F. Gaines Creek, Mississippi.
  142 G. Bogue Homo, Mississippi.
  142 H. Tallahalla Creek, Mississippi.
  142 J. Bowie Creek, Mississippi.
  142 K. Okalona Creek, Mississippi.
  142 L. Okahay Creek, Mississippi.
  142 M. West Tallahaga Creek, Mississippi.
  142 N. Chickasawba River, Mississippi.
  142 O. Buckatunna Creek, Mississippi.
  142 P. Skunky River, Mississippi.
  142 Q. Tallasha Creek, Mississippi.
  142 R. Okatibbee Creek, Mississippi.
143. Biloxi River, Mississippi.
  143 A. West Biloxi River, Mississippi.
144. Wolf River, Mississippi.
145. Catahoula Creek, Mississippi.
146. Pearl River, Mississippi and Louisiana.
  146 *a*. West Pearl River, Mississippi and Louisiana.
  146 A. McGee River, Mississippi.
  146 B. Bogue Chitto, Louisiana and Mississippi.
  146 C. Upper Little River, Mississippi.
  146 C*a*. Lower Little River, Mississippi.
  146 D. Holiday's Creek, Mississippi.
  146 E. Greene's Creek, Mississippi.
  146 F. White Sand Creek, Mississippi.
  146 G. Silver Creek, Mississippi.
  146 H. Strong River, Mississippi.
  146 J. Steens Creek, Mississippi.
  146 K. Furzell's Creek, Mississippi.
  146 L. Young Warrior River, Mississippi.
  146 M. Richland Creek, Mississippi.
  146 N. Labatcha Creek, Mississippi.
  146 O. Yockanockany Creek, Mississippi.
  146 P. Tallahaga River, Mississippi.
  146 Q. Yalabotch Creek, Mississippi.
147. Chifunette River, Louisiana.
  147 A. Big Phalia, Louisiana.
148. Tangipahoa River, Louisiana.
  148 A. Chappupela River, Louisiana.

149. Tickfaw River, Louisiana.
149 A. Natalbany Creek, Louisiana.
150. Amite River, Louisiana.
150 A. West Fork of Amite River, Louisiana.
150 B. Bayou Manchac, Louisiana.
151. Mississippi River, Louisiana, Mississippi, Arkansas, Kentucky, Missouri, Illinois, Iowa, Wisconsin, and Minnesota.
151 A. La Fourche Bayou, La.
151 B. Thompson Creek, Louisiana.
151 C. Big Bayou Sara, Louisiana.
151 D. Buffalo Creek, Mississippi.
151 E. RED RIVER, Louisiana, *vide* 152.
151 F. Homochitto River, Mississippi.
151 G. Second Creek, Mississippi.
151 H. Sand Creek, Mississippi.
151 J. Foster's Creek, Mississippi.
151 K. Middleton Creek, Mississippi.
151 L. Morgan's Fork of Homochitto, Mississippi.
151 M. Middle Fork of Homochitto, Mississippi.
151 N. Cobes Creek, Mississippi.
151 O. North Fork of Cobes Creek, Mississippi.
151 P. South Fork of Cobes Creek, Mississippi.
151 Q. Bayou Pierre, Mississippi.
151 Q*a*. White Oak Creek, Mississippi.
151 R. Chubby Fork of Bayou Pierre, Mississippi.
151 S. South Fork of Bayou Pierre, Mississippi.
151 T. Big Black River, Mississippi.
151 T*a*. Cabin Creek, Mississippi.
151 U. Bogue Chitto, Mississippi.
151 V. Deer Creek, Mississippi.
151 W. Senatbabea Creek, Mississippi.
151 X. Big Bywiah Creek, Mississippi.
151 Y. YAZOO RIVER, Mississippi, *vide* 153.
151 Z. ARKANSAS RIVER, Arkansas, *vide* 154.
151 A2. WHITE RIVER, Arkansas, *vide* 155.
151 B2. Phillip's Bayou, Mississippi.
151 C2. Saint Francis River, Arkansas and Missouri.
151 D2. L'Anguille River, Arkansas.
151 E2. French Bayou, Arkansas.
151 F2. Tyronza River and Lake, Arkansas.
151 G2. Little River, Arkansas and Missouri.
151 H2. Castor River, Missouri.
151 I2. Steele's Bayou, Missouri.
151 J2. Wolf River, Tennessee and Mississippi.
151 J2*a*. Nonconnah River, Tennessee.

151. Mississippi River, Louisiana, &c.—Continued.

151 K2. Loosahatchie River, Tennessee and Mississippi.
151 K2*a*. Big Creek, Tennessee and Mississippi.
151 L2. Big Hatchie, or Tuscumbia River, Tennessee.
151 L2*a*. Cone Creek, Tennessee.
151 L2*b*. Piney Creek, Tennessee.
151 L2*c*. Clear Creek, Tennessee.
151 L2*d*. Clover Creek, Tennessee.
151 M2. Forked Deer River, Tennessee.
151 N2. South Fork of Forked Deer River, Tennessee.
151 O2. Obion River, Tennessee.
151 P2. Reelfoot River and Reelfoot Lake, Tennessee.
151 P2*a*. North Fork of Forked Deer River, Tennessee.
151 Q2. Bayou Du Chien Creek, Kentucky.
151 R2. Little Obion River, Kentucky.
151 R2*a*. North Fork of Little Obion River, Kentucky.
151 R2*b*. Brush Creek, Kentucky.
151 S2. Mayfield Creek, Kentucky.
151 S2*a*. Little Mayfield Creek, Kentucky.
151 S2*b*. Wilson's Creek, Kentucky.
151 S2*c*. Sugar Creek, Kentucky.
151 T2. OHIO RIVER, Illinois, Kentucky, &c., *vide* 156.
151 U2. Clear Creek, Illinois.
151 V2. BIG MUDDY RIVER, Illinois, *vide* 162.
151 W2. Mary's River, Illinois.
151 X2. KASKASKIA RIVER, Illinois, *vide* 163.
151 Y2. Fountain Creek, Illinois.
151 Z2. Meramec River, Missouri.
151 A3. Big River, Missouri.
151 B3. Bourbeouse River, Missouri.
151 C3. Cahokia Creek, Illinois.
151 D3. MISSOURI RIVER, Missouri, *vide* 164.
151 E3. Piasa Creek, Illinois.
151 F3. ILLINOIS RIVER, Illinois, *vide* 174.
151 G3. Salt River, Missouri.
151 H3. North Fork of Salt River, Missouri.
151 J3. Kiset Creek, Illinois.
151 K3. Mill Creek, Illinois.
151 L3. Fabius River, Missouri.
151 M3. North Fabius River, Missouri.
151 N3. Rock Creek, Illinois.
151 O3. Bear Creek, Illinois.
151 P3. Fox River, Missouri and Illinois.
151 Q3. DES MOINES RIVER, Iowa, *vide* 175.
151 R3. Dugout Creek, Illinois.
151 S3. Honey Creek, Illinois.

151. Mississippi River, Louisiana, &c.—Continued.

- 151 T3. SKUNK RIVER, Iowa, *vide* 176.
- 151 U3. Henderson River, Illinois.
  - 151 V3. Cedar Creek, Illinois.
- 151 W3. Pope Creek, Illinois.
- 151 X3. Edwards River, Illinois.
  - 151 Y3. Camp Creek, Illinois.
  - 151 Z3. South Edwards River, Illinois.
- 151 A4. IOWA RIVER, Iowa, *vide* 177.
- 151 B4. Eliza Creek, Illinois.
- 151 C4. Copper Creek, Illinois.
- 151 D4. ROCK RIVER, Illinois, *vide* 178.
- 151 E4. Duck Creek, Iowa.
- 151 F4. WAPSIPINICON RIVER, Iowa, *vide* 179.
- 151 G4. Canton River, Iowa.
  - 151 H4. Farmer's Creek, Iowa.
- 151 J4. Johnsons' Creek, Illinois.
- 151 K4. Plum River, Illinois.
  - 151 L4. Camp Creek, Illinois.
  - 151 M4. East Branch, Illinois.
  - 151 N4. West Branch, Illinois.
- 151 O4. Big Rush Creek, Illinois.
- 151 P4. Apple River, Illinois.
  - 151 Q4. Irish Hollow Creek, Illinois.
- 151 R4. Small-pox Creek, Illinois.
- 151 S4. Platte River, Wisconsin.
  - 151 T4. Grant River, Wisconsin.
- 151 U4. Turkey River, Iowa.
  - 151 V4. Volga River, Iowa.
  - 151 W4. Cran Creek, Iowa.
- 151 X4. WISCONSIN RIVER, Wisconsin, *vide* 180.
- 151 Y4. Yellow River, Iowa.
- 151 Z4. Paint Creek, Iowa.
- 151 A5. Upper Iowa River, Iowa.
  - 151 B5. French Creek, Iowa.
  - 151 C5. Silver Creek, Iowa.
  - 151 D5. Bear Creek, Iowa.
  - 151 E5. Canoe River, Iowa.
    - 151 F5. Ten-Mile Creek, Iowa.
    - 151 G5. Silver Creek, Iowa.
- 151 H5. Raccoon River, Wisconsin.
- 151 J5. Watson Creek, Minnesota.
- 151 K5. Black River, Wisconsin.
- 151 L5. Poplar River, Wisconsin.
- 151 M5. Trempealeau, River, Wisconsin.
  - 151 N5. Pigeon Creek, Wisconsin.

151. Mississippi River, Louisiana, &c.—Continued.

151 O5. Zumbro River, Minnesota.
151 P5. CHIPPEWA RIVER, Wisconsin, *vide* 181.
151 Q5. Lake Pepin, Wisconsin.
151 R5. Cannon River, Minnesota.
151 S5. ST. CROIX RIVER, Wisconsin, *vide* 182.
151 T5. MINNESOTA RIVER, Minnesota, *vide* 183.
151 U5. Rum River, Minnesota.
151 V5. Crow River, Minnesota.
151 W5. South Fork of Crow River, Minnesota.
151 X5. Buffalo River, Minnesota.
151 Y5. Lakes Lillian, Kandiyohi, and Minitaga, Minnesota.
151 Z5. North Fork of Crow River, Minnesota.
151 A6. Green Lake, Minnesota.
151 B6. Elk River, Minnesota.
151 C6. Sauk River and Lake, Minnesota.
151 D6. Platte River and Lake, Minnesota.
151 E6. Swan River, Minnesota.
151 F6. Elk River, Minnesota.
151 G6. Nokay River, Minnesota.
151 H6. Crow Wing River, Minnesota.
151 J6. Long Prairie River, Minnesota.
151 K6. Partridge River, Minnesota.
151 L6. Leaf River, Minnesota.
151 M6. Pine River, Minnesota.
151 N6. Whitefish, Norway, and Ada Lakes.
151 O6. Ponto and Mountain Lakes, Minnesota.
151 P6. Willow River, Minnesota.
151 Q6. Sandy, Pokegoma, and Swan Lakes, Minnesota.
151 R6. Deer River and Lakes, Minnesota.
151 S6. Leech River and Lake, Minnesota.
151 T6. Kwiwissenes River, and Lake Hasster, Minnesota.
151 U6. Lakes Winnibigoshish, Cass, Pemidji, and Itasca, Minnesota.

152. Red River, Louisiana.

152 A. Atchafaylaya River, Louisiana.
152 B. Lake Moreau, Louisiana.
152 C. Rouge Bayou, Louisiana.
152 D. Boeuf Bayou, Louisiana.
152 E. Black River, Louisiana.
152 F. Tensas Bayou, Louisiana.
152 G. Bayou Macon, Louisiana.
152 H. Bayou Louis, Louisiana.
152 J. Deer Creek, Louisiana.

152. Red River, Louisiana—Continued.

152 K. Turkey Creek, Louisiana.
152 L. Boeuf River, Louisiana.
152 M. Big Creek, Louisiana.
152 N. Bee Bayou, Louisiana.
152 O. Big Bayou, Louisiana.
152 P. Bayou Boeuf, Louisiana.
152 Q. Bayou Bartholomew, Arkansas.
152 R. Washita River, Louisiana.
152 S. Bayou La Fourche, Louisiana.
152 T. Little Bayou Boeuf, Louisiana.
152 U. Corney Creek, Louisiana.
152 V. Bayou L'Arbonne, Louisiana.
152 W. Saline River, Arkansas.
152 X. Eagle Creek, Arkansas,
152 Y. Flat Creek, Arkansas.
152 Z. Brown's Creek, Arkansas.
152 A2. Cypress Creek, Arkansas.
152 B2. Big Creek, Arkansas.
152 C2. North Fork of Saline River, Arkansas.
152 D2. Middle Fork of Saline River, Arkansas.
152 E2. Bayou Moreau, Arkansas.
152 F2. Cook's Creek, Arkansas.
152 G2. Champagnole Creek, Arkansas.
152 H2. Two Bayous, Arkansas.
152 J2. Bayou Frio, Arkansas.
152 K2. Bayou Tulip, Arkansas.
152 L2. Little Missouri River, Arkansas.
152 M2. Terre Noir Creek, Arkansas.
152 N2. Cypress Bayou, Arkansas.
152 O2. Beech Creek, Arkansas.
152 P2. Terre Rouge Creek, Arkansas.
152 Q2. Antoine Creek, Arkansas.
152 R2. Clear Fork of Little Missouri, Arkansas.
152 S2. Cypress Creek, Arkansas.
152 T2. Caddo Creek, Arkansas.
152 U2. Little Mazorn Creek, Arkansas.
152 V2. Big Mazorn Creek, Arkansas.
152 W2. North Fork of Washita River, Arkansas.
152 X2. Muddy Fork of Washita River, Arkansas.
152 Y2. Brushy Creek, Arkansas.

152. Red River, Louisiana—Continued.

152 Z2. Saline Bayou, Louisiana.
152 A3. Cross Bayou, Louisiana.
152 B3. Horsepen Creek, Louisiana.
152 C3. Catahoula Lake, Louisiana.
152 D3. Flaggon Bayou, Louisiana.
152 E3. Little River, Louisiana.
152 F3. Castor Bayou, Louisiana.
152 G3. Dugdemona River, Louisiana.
152 H3. Jatt Lake, Louisiana.
152 J3. Cane River, Louisiana.
152 K3. Casatche Bayou, Louisiana.
152 L3. Saline Lake, Louisiana.
152 M3. Saline Bayou, Louisiana.
152 N3. Black Lake, Louisiana.
152 O3. Black Lake Bayou, Louisiana.
152 P3. Pierre Bayou, Louisiana.
152 Q3. Pierre Bayou Lake, Louisiana.
152 R3. Lake Bistineau, Louisiana.
152 S3. Dauchita Bayou, Louisiana.
152 T3. Cannisnia Lake, Louisiana.
152 U3. Cypre Bayou, Louisiana.
152 V3. Tone's Bayou, Louisiana.
152 W3. Bodeau Lake, Louisiana.
152 X3. Bodeau Bayou, Louisiana.
152 Y3. Cross Lake, Soda Lake, Caddo Lake, Ferry Lake, Cypress Creek, and Black Bayou, Louisiana and Texas.
152 Z3. Sulphur Fork of Red River, Louisiana and Texas.
152 A4. Anderson's Creek, Texas.
152 B4. White Oak Bayou, Texas.
152 C4. Booth's Creek, Texas.
152 D4. Cuthand Creek, Texas.
152 E4. North Sulphur River, Texas.
152 F4. Crockett Creek, Texas.
152 G4. South Sulphur River, Texas.
152 H4. Little River, Arkansas and Indian Territory.
152 J4. Saline Creek, Arkansas.
152 K4. Rolling Fork, Arkansas and Indian Territory.
152 L4. Buffalo Creek, Indian Territory.
152 M4. Pecan Bayou, Texas.
152 N4. Kimishi River, Indian Territory.
152 O4. Bushy Creek, Indian Territory.
152 P4. Big Creek, Indian Territory.
152 Q4. Black Fork Creek, Indian Territory.
152 R4. Buffalo Creek, Indian Territory.
152 S4. Haw Creek, Indian Territory.

152. Red River, Louisiana—Continued.

152 T4. Upper Pins Creek, Texas.
152 U4. Boggy River, Indian Territory.
152 V4. Middle Boggy River, Indian Territory.
152 W4. Sander's Creek, Texas.
152 X4. Coffee Mill Creek, Texas.
152 Y4. Blue River, Indian Territory,
152 Z4. Island Bayou, Indian Territory.
152 A5. Washita River, Indian Territory.
152 B5. Caddo Creek, Indian Territory.
152 C5. Wild Horse Creek, Indian Territory.
152 D5. Rush Creek, Indian Territory.
152 E5. Little Washita River, Indian Territory.
152 F5. Pond Creek, Indian Territory.
152 G5. Seventh Cavalry Creek, Indian Territory.
152 H5. Sergeant Major Creek, Indian Territory.
152 J5. Gageby Creek, Indian Territory and Texas.
152 K5. Dry Fork of Washita River, Texas.
152 L5. Walnut Creek, Indian Territory.
152 M5. Fish Creek, Indian Territory.
152 N5. Mud Creek, Indian Territory.
152 O5. Red Oak Fork, Indian Territory.
152 P5. Farmers Creek, Texas.
152 Q5. Panther Creek, Texas.
152 R5. Coffee Creek, Texas.
152 S5. Belknap Creek, Texas.
152 T5. Little Wichita River, Texas.
152 U5. Turkey Creek, Texas.
152 V5. East Fork, Texas.
152 W5. Mosquito Creek, Texas.
152 X5. Solomon Creek, Texas.
152 Y5. Union Creek, Texas.
152 Z5. North Fork of Little Wichita River, Texas.
152 A6. Middle Fork, Texas.
152 B6. South Fork, Texas.
152 C6. Big Wichita River, Texas.
152 D6. Holliday Creek, Texas.
152 E6. Plum Creek, Texas.
152 F6. Buffalo Head Creek, Texas.
152 G6. Beaver Creek, Texas.
152 H6. Mionas Creek, Texas.
152 J6. Jennie's Creek, Texas.
152 K6. Lilley's Creek, Texas.
152 L6. Main Beaver Creek, Indian Territory.
152 M6. Little Beaver Creek, Indian Territory.
152 N6. Cache Creek, Indian Territory.

152. Red River, Louisiana—Continued.
152 O6. West Fork, Indian Territory.
152 P6. Buffalo Creek, Indian Territory.
152 Q6. Deep Red Creek, Indian Territory.
152 R6. Snake Creek, Indian Territory.
152 S6. Herd Creek, Indian Territory.
152 T6. China Tree Creek, Texas.
152 U6. Buffalo Creek, Texas.
152 V6. Pease River (or South Fork Red River), Texas.
152 W6. North Fork of Pease River, Texas.
152 X6. South Fork of Pease River, Texas.
152 Y6. North Fork of Red River, Indian Territory and Texas.
152 Z6. Otter Creek, Indian Territory.
152 A7. Elk Creek, Indian Territory.
152 B7. Elm or Marcy's Creek, Indian Territory and Texas.
152 C7. Camp Creek, Indian Territory and Texas.
152 D7. Whitefish Creek, Indian Territory and Texas.
152 E7. Buffalo Creek, Indian Territory.
152 F7. Sweetwater Creek, Indian Territory and Texas.
152 G7. McClelland Creek, Texas.
152 H7. Prairie Dog Town Fork of Red River, Indian Territory and Texas.
152 J7. Freshwater Creek, Texas.
152 K7. Salt Fork of Red River, Indian Territory and Texas.
152 L7. Deep Red Run, Indian Territory.
152 M7. Gypsum Creek, Indian Territory.
152 N7. Clear Creek, Texas.
152 O7. Mulberry Creek, Texas.
152 P7. South Fork of Red River, Texas.
152 Q7. Falls and head of Red River, Randall, and Armstrong Counties, Texas.

153. Yazoo River, Mississippi.
153 A. False River, Mississippi.
153 B. Sunflower River, Mississippi.
153 C. Silver Creek, Mississippi.
153 D. Bayou Philia, Mississippi.
153 E. Deer Creek, Mississippi.
153 F. Shackelford Bayou, Mississippi.
153 G. Thompkin's Bayou, Mississippi.
153 H. Barrow's and Goose Lakes, Mississippi.
153 J. Alligator Creek, Mississippi.
153 K. Techevah Creek, Mississippi.
153 L. Tehulah River, Mississippi.
153 M. Black, or Bloosa Creek, Mississippi.

153. Yazoo River, Mississippi—Continued.
153 N. Fannegusha Creek, Mississippi.
153 O. Chicopah Bayou, Mississippi.
153 P. Abyacha Coula Creek, Mississippi.
153 Q. Palusha Creek, Mississippi.
153 R. Big Sandy Creek, Mississippi.
153 S. Yalabusha River, Mississippi.
153 T. Batupon Bogue, Mississippi.
153 U. Patacocawa Creek, Mississippi.
153 V. Loosha Scoona River, Mississippi.
153 W. Botmore Creek, Mississippi.
153 X. Cold Water River, Mississippi.
153 Y. Cositys Bayou, Mississippi.
153 Z. Tallahatchee River, Mississippi.
153 A2. Yockeney River, Mississippi.
153 B2. Wyoh-Na-Pata-Fa River, Mississippi.
153 C2. Otoclaffa Creek, Mississippi.
153 D2. Tippah Creek, Mississippi.
153 E2. Issaquena Creek, Mississippi.
154. Arkansas River, Arkansas and Indian Territory.
154 A. Rattlesnake Bayou, Arkansas.
154 A*a*. Bayou Meto, Arkansas.
154 B. Bayou Two Prairies, Arkansas.
154 B*a*. Little Bayou Meto, Arkansas.
154 C. Maumelle River, Arkansas.
154 D. Cypress Lake, Arkansas.
154 E. Fourche La Fave River, Arkansas.
154 F. Grape Creek, Arkansas.
154 G. Cauldron Creek, Arkansas.
154 H. North Fork of Cauldron Creek, Arkansas.
154 J. Petit Jean Creek, Arkansas.
154 K. Dutch Creek, Arkansas.
154 L. Illinois Creek, Arkansas.
154 M. Bear Creek, Arkansas.
154 N. Piney Creek, Arkansas.
154 O. Little Piney Creek, Arkansas.
154 P. Cane Creek, Arkansas.
154 Q. Mulberry River, Arkansas.
154 R. Richland Creek, Arkansas.
154 S. Lees Creek, Arkansas.
154 T. Basil Creek, Indian Territory.
154 U. Skin Creek, Indian Territory.
154 V. Sallison Creek, Indian Territory.
154 W. Sand Bois Creek, Indian Territory.
154 X. Vine Creek, Indian Territory.
154 Y. Canadian River, Indian Territory.

154. Arkansas River, Arkansas and Indian Territory—Continued.

154 Z. Rabbit Ear Creek, or North Fork of Canadian River.
154 A2. Deep Fork, Indian Territory.
154 B2. We-woka River, Indian Territory.
154 C2. Wolf Creek, Indian Territory.
154 D2. Middle River, Texas.
154 E2. Trout Creek, Indian Territory.
154 F2. Paladoro, or Skull Creek, Indian Territory and Texas.
154 G2. Union Creek, Indian Territory and Texas.
154 H2. Dry River, Indian Territory and Texas.
154 J2. Beaver Creek, Texas.
154 K2. McNeiss Creek, Indian Territory.
154 L2. Coal Creek, Indian Territory.
154 M2. Grain Creek, Indian Territory.
154 N2. Brushy Creek, Indian Territory.
154 O2. Little River, Indian Territory.
154 P2. Walnut Creek, Indian Territory.
154 Q2. Deer Creek, Indian Territory.
154 R2. Commission Creek, Indian Territory.
154 S2. Dry River, Texas.
154 T2. Kiowa Creek, Texas.
154 U2. Valley Creek, Texas.
154 V2. Kit Carson Creek, Texas.
154 W2. Big Clear, or Mustang Creek, Texas.
154 X2. Little Clear Creek, Texas.
154 A3. Spring Creek, Texas.
154 B3. Bluff Creek, Texas.
154 C3. Moale Creek, Texas.
154 D3. Agua Azul River, Texas.
154 E3. Shady Creek, Texas.
154 F3. Beautiful View Creek, Texas.
154 G3. Canada Rica Creek, Texas.
154 H3. Rincon de la Cruz Creek, Texas.
154 J3. Ca Bonito Creek, Texas.
154 K3. Encampment Creek, Texas.
154 L3. Major Long's Creek, Texas and New Mexico.
154 M3. Trujillo Creek, Texas and New Mexico.
154 N3. Flagg Creek, Indian Territory and New Mexico.
154 O3. Canada de Trujillo Creek, New Mexico.
154 P3. Red River Springs, Indian Territory.
154 Q3. Rocky Bell Creek, Indian Territory.
154 R3. Monte Bevuleta Tucumcari Creek, New Mexico.
154 S3. Hall Creek, New Mexico.
154 T3. Barrancas Creek, New Mexico.

154\. Arkansas River, Arkansas and Indian Territory—Continued.

154 U3. Utah Creek, New Mexico.
154 V3. Alamo Creek, New Mexico.
154 W3. Pajarito Creek, or Tierra Blanca, New Mexico.
154 X3. Rio Concha Creek, New Mexico.
154 Y3. Arroyo Guerbo, New Mexico.
154 Z3. Rio Mora, New Mexico.
154 A4. Le Blanco Creek, New Mexico.
154 B4. Dog Creek, New Mexico.
154 C4. Rio Sapello, New Mexico.
154 D4. Rio Cebollas, New Mexico.
154 E4. Elk Lake, New Mexico.
154 F4. Don Carlos Creek, New Mexico.
154 G4. Laguna River, New Mexico.
154 H4. Whetstone River, New Mexico.
154 J4. Sweetwater Creek New Mexico.
154 K4. Rayado River, New Mexico.
154 L4. Rio Cimarron, New Mexico.
154 M4. Rio Vermijo, New Mexico.
154 N4. Crow Creek, New Mexico.
154 O4. Una de Gato Creek, New Mexico.
154 P4. Illinois River, Indian Territory.
154 Q4. Flint Creek, Indian Territory and Missouri.
154 R4. Barren Fork, Indian Territory and Missouri.
154 S4. Illinois Creek, Indian Territory and Missouri.
154 T4. Elk Creek, Indian Territory.
154 U4. Coodeys Creek, Indian Territory.
154 V4. Neosho River, Indian Territory and Kansas.
154 W4. Flat Rock Creek, Indian Territory.
154 X4. Fourteen-mile Creek, Indian Territory.
154 Y4. Spring Creek, Indian Territory.
154 Z4. Saline Creek, Indian Territory.
154 A5. Spavina Creek, Indian Territory and Missouri.
154 B5. Cabin Creek, Indian Territory.
154 C5. Elk Creek, Indian Territory.
154 D5. Sugar Creek, Arkansas.
154 D5*a*. Shoal Creek, Missouri.
154 E5. Verdigris River, Indian Territory and Kansas.
154 F5. Bird Creek, Indian Territory.
154 G5. Big Caney Creek, Indian Territory.
154 H5. Pocan Creek, Indian Territory.
154 J5. Cane Creek, Indian Territory.
154 K5. Snake Creek, Indian Territory.
154 L5. Polecat Creek, Indian Territory.
154 M5. Red Fork of Arkansas River, Indian Territory.
154 N5. Black Bear Creek, Indian Territory.

154. Arkansas River, Arkansas and Indian Territory—Continued.

154 O5. Chisholms' Creek, Indian Territory.
154 P5. Cottonwood Creek, Indian Territory.
154 Q5. Uncle John, or Kingfisher Creek, Indian Territory.
154 R5. Glauber Salt Creek, Indian Territory.
154 S5. Sand Creek, Indian Territory.
154 T5. Buffalo Creek, Indian Territory.
154 U5. Snake Creek, Indian Territory.
154 V5. Bluff Creek, Indian Territory.
154 W5. Sa-Tau-Tas Creek, Indian Territory.
154 X5. Fish Creek, Indian Territory.
154 Y5. Cimarron River, Kansas and Indian Territory.
154 Z5. Bear Creek, Kansas.
154 A6. Salt Creek, Kansas.
154 B6. Crooked Creek, Kansas.
154 C6. Sand Creek, Kansas.
154 D6. Cold Spring Creek, Texas.
154 E6. Cedar Creek, Texas.
154 F6. Willow Creek, Colorado.
154 G6. Salt, or Nescutunga River, Indian Territory and Kansas.
154 H6. Medicine Lodge Creek, Kansas.
154 J6. Cavalry Creek, Kansas.
154 K6. Bluff Creek, Indian Territory and Kansas.
154 L6. Pahabe Creek, Indian Territory.
154 M6. Snawacospah or Chikaskie River, Indian Territory and Kansas.
154 N6. Ne-Ne-Squaw River, Kansas.
154 O6. South Fork of Ne-Ne-Squaw River, Kansas.
154 P6. North Fork of Ne-Ne-Squaw River, Kansas.
154 Q6. Cow Skin Creek, Kansas.
154 R6. Little Arkansas River, Kansas.
154 S6. Rattlesnake Creek, Kansas,
154 T6. Walnut Creek, Kansas.
154 U6. South Fork of Walnut Creek, Kansas.
154 V6. Sandy Bed Creek, Kansas.
154 W6. Ash Creek, Kansas.
154 X6. Pawnee Creek, Kansas.
154 Y6. Buckner's Branch, Kansas.
154 Z6. Shaff's Branch, Kansas.
154 A7. Heth's Branch, Kansas.
154 B7. Coon Creek, Kansas.
154 C7. Mulberry Creek, Kansas.
154 D7. Bear Creek, Kansas.
154 E7. Two Butte Creek, Colorado.

154. Arkansas River, Arkansas and Indian Territory—Continued.

154 F7. Clay Creek, Colorado.
154 G7. Big Sandy Creek, Colorado.
154 H7. Rush Creek, Colorado.
154 J7. Wild Horse Creek, Colorado.
154 K7. Caddo Creek, Colorado.
154 L7. Rule Creek, Colorado.
154 M7. Purgatory River, Colorado.
154 N7. Higby Cañon Creek, Colorado.
154 O7. Chaquague Creek, Colorado.
154 P7. Chickoa Creek, Colorado.
154 Q7. Las Animas River, Colorado.
154 R7. Dry Creek, Colorado.
154 S7. Duck, or Little Sandy Creek, Colorado.
154 T7. Timpa Creek, Colorado.
154 U7. Apishapa Creek, Colorado.
154 V7. Huerfano River, Colorado.
154 W7. Cucharas River, Colorado.
154 X7. Santa Clara Creek, Colorado.
154 Y7. Apache Creek, Colorado.
154 Z7. William's Creek, Colorado.
154 A8. Black Squirrel Creek, Colorado.
154 B8. Chico Creek, Colorado.
154 C8. Saint Charles River, Colorado.
154 D8. Greenhorn River, Colorado.
154 E8. Muddy Creek, Colorado.
154 F8. Fountaine Qui Bouille Creek, Colorado.
154 G8. Little Fountaine Creek, Colorado.
154 H8. Rock Creek, Colorado.
154 J8. Turkey Creek, Colorado.
154 K8. Beaver Creek, Colorado.
154 L8. Great Creek, Colorado.
154 M8. Oil Creek, Colorado.
154 N8. Texas Creek, Colorado.
154 O8. Brown Creek, Colorado.
154 P8. Chalk Creek, Colorado.
154 Q8. Cottonwood Creek, Colorado.
154 R8. Twin Lakes, source of Arkansas River, near Leadville, Colorado.

155. White River, Arkansas.

155 A. La Grue River, Arkansas.
155 B. Little River or Big Creek, Arkansas.
155 C Cache River, Arkansas.
155 D. Bayou Devue, Arkansas.
155 E. Cypress Bayou, Arkansas.
155 F. Little Red River, Arkansas.

155. White River, Arkansas—Continued.
- 155 G. Turkey Creek, Arkansas.
- 155 H. Old Fork of Little Red River, Arkansas.
- 155 J. Village Creek, Arkansas.
- 155 K. Black River, Arkansas.
- 155 L. Strawberry River, Arkansas.
- 155 M. Piney Fork of Strawberry River, Arkansas.
- 155 N. Spring River, Arkansas and Missouri.
- 155 O. Eleven Points River, Arkansas and Missouri.
- 155 P. James Creek, Arkansas.
- 155 Q. Hyatts Fork of Spring River, Arkansas.
- 155 R. Current River, Arkansas and Missouri.
- 155 S. Little Black River, Arkansas and Missouri.
- 155 T. Jack's Fork of Current River, Missouri.
- 155 U. Big North Fork of White River, Arkansas and Missouri.
- 155 V. Buffalo Fork of White River, Arkansas.
- 155 W. Hoges Creek, Arkansas.
- 155 X. Calf Creek, Arkansas.
- 155 Y. Richland Creek, Arkansas.
- 155 Z. Crooked Creek, Arkansas.
- 155 A2. Sugar-Loaf Creek, Arkansas.
- 155 B2. Bear Creek, Arkansas.
- 155 C2. Big Beaver Creek, Arkansas.
- 155 D2. Swan Creek, Arkansas.
- 155 E2. Long Creek, Arkansas.
- 155 F2. West Fork of Long Creek, Arkansas and Missouri.
- 155 G2. Flat Creek, Missouri.
- 155 H2. King's River, Missouri and Arkansas.
- 155 J2. Main Fork of White River, Missouri.
- 155 K2. Nubbins Creek, Missouri.

156. Ohio River, Illinois, Indiana, Ohio, Kentucky, West Virginia, Pennsylvania.
- 156 A. Big Wheeling Creek, Pennsylvania.
- 156 B. Big Grave Creek, Pennsylvania.
- 156 C. Fish Creek, Pennsylvania.
- 156 D. Fishing Creek, Pennsylvania.
- 156 E. Middle Island Creek, Pennsylvania.
- 156 F. McElroy Creek, Pennsylvania.
- 156 G. French Creek, Pennsylvania.
- 156 H. Buffalo Creek, West Virginia and Pennsylvania.
- 156 J. Cross Creek, West Virginia and Pennsylvania.
- 156 K. Tygarts Creek, Kentucky.
- 156 L. Grassy Creek, Kentucky.
- 156 M. Kinniconick Creek, Kentucky.

156\. Ohio River, Illinois, Indiana, Ohio, &c.—Continued.

156 N. Calio Creek, Kentucky.
156 O. Twelve-Mile Creek, Kentucky.
156 A2. TENNESSEE RIVER, Kentucky, *vide* 157.
156 B2. CUMBERLAND RIVER, Kentucky and Tennessee, *vide* 158.
156 C2. Saline River, Illlnois.
156 D2. North Fork of Saline River, Illinois.
156 E2. South Fork of Saline River, Illinois.
156 F2. Wabash River, Indiana.
156 G2. Little Wabash River, Indiana.
156 H2. White River, Indiana.
156 J2. East Fork of White River, Indiana.
156 K2. West Fork of White River, Indiana.
156 L2. Embarras River, Illinois.
156 M2. Tippecanoe River, Indiana.
156 N2. Eel River, Indiana.
156 O2. Mississinneau River, Indiana.
156 P2. Cypress Creek, Indiana.
156 Q2. Sallamoni River, Indiana.
156 R2. Lost Creek, Indiana.
156 S2. Tradewater River, Kentucky.
156 T2. Highland Creek, Kentucky.
156 U2. Green River, Kentucky.
156 V2. Little Barren River, Kentucky.
156 W2. East Fork of Little Barren River, Kentucky.
156 X2. Middle Fork of Little Barren River, Kentucky.
156 Y2. South Fork of Little Barren River, Kentucky.
156 Z2. Panther Creek, Kentucky.
156 A3. East Fork of Panther Creek, Kentucky.
156 B3. Deer Creek, Kentucky.
156 C3. Plum Creek, Kentucky.
156 D3. Muddy Creek, Kentucky.
156 E3. Indian Camp Creek, Kentucky.
156 F3. Welsh's Creek, Kentucky.
156 G3. Clay Lick Creek, Kentucky.
156 H3. Bear Creek, Kentucky.
156 J3. Beaverdam Creek, Kentucky.
156 K3. Brush Creek, Kentucky.
156 L3. Pitman's Creek, Kentucky.
156 M3. Russell's Creek, Kentucky.
156 N3. Sulphur Creek, Kentucky.
156 O3. Glenn Creek, Kentucky.
156 P3. Reynold's Creek, Kentucky.
156 Q3. Robinson's Creek, Kentucky.
156 R3. Casey Creek, Kentucky.

156. Ohio River, Illinois, Indiana, Ohio, &c.—Continued.

156 S3. Nolin River, Kentucky.
156 T3. Bacon Creek, Kentucky.
156 U3. Roundstone Creek, Kentucky.
156 V3. Severn Valley Creek, Kentucky.
156 W3. North Fork of Nolin River, Kentucky.
156 X3. South Fork of Nolin River, Kentucky.
156 Y3. Rough Creek, Kentucky.
156 Z3. Muddy Creek, Kentucky.
156 A4. Caney Creek, Kentucky.
156 B4. North Fork of Rough Creek, Kentucky.
156 C4. Pond River, Kentucky.
156 D4. Cypress Creek, Kentucky.
156 E4. Otter Creek, Kentucky.
156 F4. West Fork of Pond River, Kentucky.
156 G4. Long Creek, Kentucky.
156 H4. Muddy River, Kentucky.
156 J4. Clifty Creek, Kentucky.
156 K4. Pigeon Roost Creek, Kentucky.
156 L4. Wolf Creek, Kentucky.
156 M4. Big Barren River, Kentucky.
156 N4. Gasper's River, Kentucky.
156 O4. Clear Fork of Gasper's River, Kentucky.
156 P4. Drake's Fork, Kentucky.
156 Q4. Sinking Creek, Kentucky.
156 R4. West Fork of Sinking Creek, Kentucky.
156 S4. Sulphur Fork, Kentucky.
156 T4. Trammel's Fork, Kentucky.
156 U4. Ray's Fork, Kentucky.
156 V4. Beaver Creek, Kentucky.
156 W4. Boyd's Creek, Kentucky.
156 X4. Skagg's Creek, Kentucky.
156 Y4. Peters Creek, Kentucky.
156 Z4. Long Creek, Kentucky.
156 A5. Lick Creek, Kentucky.
156 B5. Indian Creek, Kentucky.
156 C5. Long Fork of Big Barren River, Kentucky.
156 D5. East Fork of Big Barren River, Kentucky.
156 E5. Salt River, Kentucky.
156 F5. Pond Creek, Kentucky.
156 G5. Floyd's Fork, Kentucky.

156. Ohio River, Illinois, Indiana, Ohio, &c.—Continued.

156 H5. Rolling Fork of Salt River, Kentucky.
156 J5. Beech Fork, Kentucky.
156 K5. Hardins Creek, Kentucky.
156 L5. Chaplin Fork, Kentucky.
156 M5. Sulphur Creek, Kentucky.
156 N5. Otter Creek, Kentucky.
156 O5. Kentucky River, Kentucky.
156 P5. Eagle Creek, Kentucky.
156 Q5. Ten-Mile Creek, Kentucky.
156 R5. Tyells Fork, Kentucky.
156 S5. Drennan Creek, Kentucky.
156 T5. Six-Mile Creek, Kentucky.
156 U5. Cedar Creek, Kentucky.
156 V5. Sand Creek, Kentucky.
156 W5. Elkhorn Creek, Kentucky.
156 X5. Hickman Creek, Kentucky.
156 Y5. Paint Lick [Creek], Kentucky.
156 Z5. Silver Creek, Kentucky.
156 A6. Boone's Creek, Kentucky.
156 B6. Otter Creek, Kentucky.
156 C6. Muddy Creek, Kentucky.
156 D6. Drowning Creek, Kentucky.
156 E6. Station Camp Creek, Kentucky.
156 F6. Sturgeons Creek, Kentucky.
156 G6. Sextons Creek, Kentucky.
156 H6. Red Bird Fork, Kentucky.
156 J6. Goose Creek, Kentucky.
156 K6. East Fork, Kentucky.
156 L6. Collins Fork, Kentucky.
156 M6. Cutshin Creek, Kentucky.
156 N6. Greasy Creek, Kentucky.
156 O6. Quicksand Creek, Kentucky.
156 P6. Troublesome Creek, Kentucky.
156 Q6. Lost Creek, Kentucky.
156 R6. Big Creek, Kentucky.
156 S6. Buckhorn Creek, Kentucky.
156 T6. Carr's Fork, Kentucky.
156 U6. Rockhouse Creek, Kentucky.
156 V6. Dick's River, Kentucky.
156 W6. Otter Creek, Kentucky.
156 X6. Sinking Creek, Kentucky.
156 Y6. Red River, Kentucky.
156 Z6. Clover Creek, Kentucky.
156 A7. North Fork of Kentucky River, Kentucky.
156 B7. Middle Fork of Kentucky River, Kentucky.

156. Ohio River, Illinois, Indiana, Ohio, &c.—Continued.

156 C7. South Fork of Kentucky River, Kentucky.
156 D7. Little Kentucky River, Kentucky.
156 E7. Miami River, Ohio.
156 F7. Blackford's Creek, Kentucky.
156 G7. Licking River, Kentucky.
156 H7. North Fork of Licking River, Kentucky.
156 J7. South Fork of Licking River, Kentucky.
156 K7. Flat Creek, Kentucky.
156 L7. Fox Creek, Kentucky.
156 M7. Slate Creek, Kentucky.
156 N7. Christy Creek, Kentucky.
156 O7. Triplett's Creek, Kentucky.
156 P7. North Fork, Kentucky.
156 Q7. Elk Fork, Kentucky.
156 R7. Little Miami River, Ohio.
156 S7. East Fork of Little Miami, Ohio.
156 T7. Scioto River, Ohio.
156 U7. Deer Creek, Ohio.
156 V7. Little Sandy River, Kentucky.
156 W7. East Fork of Little Sandy River, Kentucky.
156 X7. Little Fork of Little Sandy River, Kentucky.
156 Y7. Dry Fork of Little Sandy River, Kentucky.
156 Z7. Crooked Creek, Kentucky.
156 A8. Tradewater River, Kentucky.
156 B8. Crab Orchard Creek, Kentucky.
156 C8. Pond Creek, Kentucky.
156 D8. Pogues Creek, Kentucky.
156 E8. Donaldson Creek, Kentucky.
156 F8. Caney Creek, Kentucky.
156 G8. Big Sandy River, Kentucky.
156 H8. Tug Fork of Big Sandy, Kentucky.
156 J8. Pigeon Creek, Kentucky.
156 K8. Tug Run, Kentucky.
156 L8. Panther Creek, Kentucky.
156 M8. South Fork, Kentucky.
156 N8. Camp Creek, Kentucky.
156 O8. West Fork of Big Sandy, Kentucky.
156 P8. Louisa Fork of Big Sandy, Kentucky.
156 Q8. Russel Fork of Big Sandy, Kentucky.
156 R8. Pound Fork of Big Sandy, Kentucky.
156 S8. GREAT KANAWHA RIVER, West Virginia, *vide* 159.
156 T8. Guyandotte River, West Virginia.
156 U8. Mud River, West Virginia.
156 V8. Trade Fork, West Virginia.
156 W8. Buffalo Creek, West Virginia.

156. Ohio River, Illinois, Indiana, Ohio, &c.—Continued.

156 X8. Clear Fork, West Virginia.
156 Y8. Rockcastle Creek, West Virginia.
156 Z8. Twelve-Pole Creek, West Virginia.
156 A9. Right Fork, West Virginia.
156 B9. Hockhocking River, Ohio.
156 C9. LITTLE KANAWHA RIVER, Ohio, *vide* 160.
156 D9. Pond Creek, Ohio.
156 E9. Sandy Creek, Ohio.
156 F9. Mill Creek, Ohio.
156 G9. Muskingum River, Ohio.
156 H9. Licking River, Ohio.
156 J9. White Woman River, Ohio.
156 K9. Tuscarawas River, Ohio.
156 L9. Beaver River, Pennsylvania.
156 M9. MONONGAHELA RIVER, Pennsylvania, *vide* 161.
156 N9. Alleghany River, Pennsylvania.
156 O9. Kiskiminitas River, Pennsylvania.
156 P9. Conemaugh River, Pennsylvania.
156 Q9. Loyalhanna River, Pennsylvania.
156 R9. Yellow Branch, Pennsylvania.
156 S9. Clarion River, Pennsylvania.
156 T9. French Creek, Pennsylvania.
156 U9. Oil Creek, Pennsylvania.
156 V9. Tionesta Creek, Pennsylvania.
156 W9. Conewango Creek, Pennsylvania.
156 X9. Mamac Creek, Kentucky.
156 Y9. Humphrey's Creek, Kentucky.

157. Tennessee River, Tennessee, Kentucky, and North Carolina.

157 A. Clark River, Kentucky.
157 B. East Fork of Clark River, Kentucky.
157 C. West Fork of Clark River, Kentucky.
157 D. Blood River, Kentucky.
157 E. Big Sandy River, Tennessee.
157 F. White Oak Creek, Tennessee.
157 G. Big Richland Creek, Tennessee.
157 H. Duck River, Tennessee.
157 J. Buffalo River, Tennessee.
157 K. Hurricane Creek, Tennessee.
157 L. Piney Creek, Tennessee.
157 M. Mill Creek, Tennessee.
157 N. Big Bigbee Creek, Tennessee.
157 O. Little Bigbee Creek, Tennessee.
157 P. Beech River, Tennessee.
157 Q. Indian Creek, Tennessee.
157 R. Cypress Creek, Alabama.

157. Tennessee River, Tennessee, Kentucky, and North Carolina—Cont'd.

157 S. Shoal Creek, Alabama.
157 T. Flint River, Alabama.
157 U. Big Bear Creek, Alabama.
157 V. Cedar Creek, Alabama.
157 W. Elk River, Alabama and Tennessee.
157 X. Sugar Creek, Alabama and Tennessee
157 Y. Horse Creek, Tennessee.
157 Z. Richland Creek, Tennessee.
157 A2. Cold Water Creek, Tennessee.
157 B2. Mulberry Creek, Tennessee.
157 C2. Flint River, Alabama.
157 D2. Shoal Creek, Alabama.
157 E2. Paint Rock River, Alabama.
157 F2. Battle Creek, Tennessee.
157 G2. Santas Creek, Alabama.
157 H2. Town Creek, Alabama.
157 J2. Nanwee Creek, Alabama.
157 K2. Sequatchie River, Tennessee.
157 L2. Chickamauga Creek, Georgia.
157 M2. Hiwassee River, Tennessee.
157 N2. Chattanooga Creek, Georgia and Tennessee.
157 O2. Ocoee River, Tennessee.
157 P2. Chestua Creek, Tennessee.
157 Q2. Nottleg River, North Carolina.
157 R2. Spring Creek, Tennessee.
157 S2. Candy Creek, Tennessee.
157 T2. Mouse Creek, Tennessee.
157 U2. Canasauga Creek, Tennessee.
157 V2. Big Emory River, Tennessee.
157 W2. Daddy's Creek, Tennessee.
157 X2. Obeds Creek, Tennessee.
157 Y2. Clear Creek, Tennessee.
157 Z2. Emory Creek, Tennessee.
157 A3. Clinch River, Tennessee.
157 B3. Poplar Creek, Tennessee.
157 C3. Beaver Creek, Tennessee.
157 D3. Bull Run Creek, Tennessee.
157 E3. Cove Creek, Tennessee.
157 F3. North Fork of Clinch River, Virginia.
157 G3. Powell's River, Tennessee.
157 H3. Indian Creek, Virginia.
157 J3. Little Tennessee River, Tennessee.
157 K3. Little River, Tennessee.
157 L3. Tellico River, Tennessee.
157 M3. Cilico Creek, Tennessee.

157. Tennessee River, Tennessee, Kentucky, and North Carolina—Continued.
- 157 N3. Abrams Creek, Tennessee.
- 157 O3. Cheowah Creek, North Carolina.
- 157 P3. Tuckasegee River, North Carolina.
- 157 Q3. Ocnaluftee River, North Carolina.
- 157 R3. Nantahelah River, North Carolina.
- 157 S3. Holston River, Tennessee and West Virginia.
- 157 T3. Reedy Creek, Tennessee.
- 157 U3. Stony Creek, Tennessee.
- 157 V3. North Fork of Holston, West Virginia.
- 157 V3*a*. Middle Fork of Holston, West Virginia.
- 157 W3. South Fork of Holston, West Virginia.
- 157 X3. Watauga River, Tennessee.
- 157 Y3. Roane Creek, Tennessee.
- 157 Z3. Big Doe River, Tennessee.
- 157 A4. French Broad River, Tennessee.
- 157 B4. Big East Fork, Tennessee.
- 157 C4. Pigeon River, Tennessee.
- 157 D4. Lick Creek, Tennessee.
- 157 E4. Iron Creek, Tennessee.
- 157 F4. Cosby Creek, Tennessee.
- 157 G4. Nolachucky River, Tenn.
- 157 H4. Big Pigeon River, Tennessee and North Carolina.
- 157 J4. Cane River, North Carolina.
- 157 K4. Ivy Creek, North Carolina.
- 157 L4. North Toe River, North Carolina.
- 157 M4. South Toe River, North Carolina.

158. Cumberland River.
- 158 A. Livingston Creek, Kentucky.
- 158 B. Bitter River, Kentucky.
- 158 C. Eddy Creek, Kentucky.
- 158 D. Little River, Kentucky.
- 158 E. Muddy Fork, Kentucky,
- 158 F. Sinking Creek, Kentucky.
- 158 G. Yellow Creek, Tennessee.
- 158 H. Red River, Tennessee.
- 158 J. West Fork of Red River, Tennessee and Kentucky.
- 158 K. Elk Fork of Red River, Tennessee and Kentucky.
- 158 L. South Fork Red River, Tennessee.
- 158 M. Big Spring Creek, Kentucky.
- 158 N. Bartons Creek, Tennessee.
- 158 O. Harpeth River, Tennessee.
- 158 P. Stone's River, Tennessee.
- 158 Q. Spring Creek, Tennessee.
- 158 R. West Fork of Stone's River, Tennessee.

158. Cumberland River, Tennessee and Kentucky—Cont'd.

158 S. East Fork of Stone's River, Tennessee.
158 T. Spring Creek, Tennessee.
158 U. Cumberland River, Caney Fork of, Tennessee.
158 V. Smith's Fork of Caney Fork, Tennessee.
158 W. Falling Water Creek, Tennessee.
158 X. Cane Creek, Tennessee.
158 Y. Collins River, Tennessee.
158 Z. Mountain Creek, Tennessee.
158 A2. Charles Creek, Tennessee.
158 B2. Barren Fork, Tennessee.
158 C2. Calf-Killer Creek, Tennessee.
158 D2. Roaring River, Tennessee.
158 E2. Spring Creek, Tennessee.
158 H2. Obeys River, Tennessee.
158 J2. Wolf River, Tennessee.
158 K2. West Fork of Obeys River, Tennessee.
158 L2. East Fork of Obeys River, Tennessee.
158 M2. Marrowbone Creek, Tennessee.
158 N2. Renick Creek, Tennessee.
158 O2. Crocus Creek, Tennessee.
158 P2. Millers Creek, Tennessee.
158 Q2. Indian Creek, Tennessee.
158 R2. Beaver Creek, Tennessee.
158 S2. Otter Creek, Tennessee.
158 T2. Caney Creek, Tennessee.
158 U2. Wolf Creek, Tennessee.
158 V2. Falls Creek, Tennessee.
158 W2. Fishing Creek, Tennessee.
158 X2. Pitman Creek, Tennessee.
158 Y2. Buck Creek, Tennessee.
158 Z2. Beaver Creek, Tennessee.
158 A3. Bark Camp Creek, Tennessee.
158 B3. Young's Creek, Tennessee.
158 C3. Marsh Creek, Tennessee.
158 D3. Jelico Creek, Tennessee.
158 E3. Clear Fork, Tennessee.
158 F3. Wolf Creek, Tennessee.
158 G3. Elk Fork, Tennessee.
158 H3. Davis Creek, Tennessee.
158 J3. Tackett's Creek, Tennessee.
158 K3. Big Poplar Creek, Tennessee.
158 L3. Little Richland Creek, Tennessee.
158 M3. West Fork of Little Richland, Tennessee.
158 N3. Stinking Branch, Tennessee.
158 O3. Turkey Creek, Tennessee.

158. Cumberland River, Tennessee and Kentucky—Continued.

158 P3. Clear Creek, Tennessee.

158 Q3. Straight Creek, Tennessee.

158 R3. Left-Hand Fork, Tennessee.

158 S3. South Fork of Cumberland River, Kentucky.

158 T3. Clear or South Fork of Cumberland River, Tennessee.

158 U3. Long Creek, Tennessee.

158 V3. Little South Fork of South Fork of Cumberland River, Tennessee.

158 W3. White Oak Creek, Tennessee.

158 Y3. New River, Tennessee.

158 Z3. Rock Castle River, Kentucky.

158 A4. South Fork of Rock Castle River, Kentucky.

158 B4. Horse Lick [Creek], Kentucky.

158 C4. Middle Fork of Rock Castle River, Kentucky.

158 D4. Laurel River, Kentucky.

158 E4. Whippoorwill Creek, Kentucky.

158 F4. Lynn Camp Creek, Kentucky.

158 G4. Clover Fork of Cumberland River, Kentucky.

158 H4. Poor Fork of Cumberland River, Kentucky.

158 J4. Yellow Creek, Kentucky.

158 K4. Picketts Creek, Kentucky.

158 L4. Martins Creek, Kentucky.

159. Great Kanawha River, West Virginia.

159 A. Pocataligo River, West Virginia.

159 B. Big Coal River, West Virginia.

159 C. Little Coal River, West Virginia.

159 D. Spruce Fork, West Virginia.

159 E. Pond Fork, West Virginia.

159 F. Elk River, West Virginia.

159 G. Point Creek, West Virginia.

159 H. Little Sandy River, West Virginia.

159 J. Big Sandy Creek, West Virginia.

159 K. Big Birch River, West Virginia.

159 L. Little Birch River, West Virginia.

159 M. Holly River, West Virginia.

159 N. Buck River, West Virginia.

159 O. Gauley River, West Virginia.

159 P. Twenty-Mile Creek, West Virginia.

159 Q. Peters Creek, West Virginia.

159 R. Harmony Creek, West Virginia.

159 S. Meadow River, West Virginia.

159 T. Cherry River, West Virginia.

159 U. North Fork, West Virginia.

159 V. South Fork, West Virginia.

159. Great Kanawha River, West Virginia—Continued.
- 159 W. Williams River, West Virginia.
- 159 X. New River, West Virginia.
- 159 Y. Piney Creek, West Virginia.
- 159 Z. Glade Creek, West Virginia.
- 159 A2. Wolf Fork, Virginia.
- 159 B2. Sinking Creek, Virginia
- 159 C2. Walker's Creek, Virginia.
- 159 D2. Greenbrier River, West Virginia.
- 159 E2. Howard's Creek, West Virginia.
- 159 F2. Spring Creek, West Virginia.
- 159 G2. Deer Creek, West Virginia.
- 159 H2. Bluestone River, West Virginia.
- 159 J2. Brush Creek, West Virginia.
- 159 K2. East River, West Virginia.
- 159 L2. Little River, West Virginia.

160. Little Kanawha River, West Virginia.
- 160 *a*. Tygart Creek, West Virginia.
- 160 A. Hughes River, West Virginia.
- 160 A*a*. Goose Creek, West Virginia.
- 160 B. North Fork of Hughes River, West Virginia.
- 160 C. South Fork of Hughes River, West Virginia.
- 160 C*a*. Indian Creek, West Virginia.
- 160 C*b*. Reedy Creek, West Virginia.
- 160 C*c*. Spring Creek, West Virginia.
- 160 D. Lee's River, West Virginia.
- 160 E. Grean's River, West Virginia.
- 160 F. Ridge's River, West Virginia.
- 160 G. Riffle's River, West Virginia.
- 160 H. West Fork of Little Kanawha River, West Virginia.
- 160 H*a*. Silver Creek, West Virginia.
- 160 H*b*. Left Fork, West Virginia.
- 160 H*c*. Cedar Creek, West Virginia.
- 160 H*d*. Leading Creek, West Virginia.
- 160 H*e*. Sand Fork, West Virginia.
- 160 J. Honey River, West Virginia.
- 160 K. Barne's River, West Virginia.
- 160 L. Triplet's River, West Virginia.
- 160 M. Powell's River, West Virginia.
- 160 N. Daniel's River, West Virginia.
- 160 O. Phillip's River, West Virginia.
- 160 P. First Two River, West Virginia.
- 160 Q. Second Two River, West Virginia.
- 160 R. Katey's River, West Virginia.
- 160 S. Phillip's River, West Virginia.
- 160 T. Grass River, West Virginia.

160. Little Kanawha River, West Virginia—Continued.
- 160 U. Right-Hand Fork of Little Kanawha River, West Virginia.
- 160 V. Duck River, West Virginia.
- 160 W. Dusky Camp River, West Virginia.
- 160 X. Sliding Hill River, West Virginia.
- 160 Y. Copen's River, West Virginia.
- 160 Z. Long Shoal River, West Virginia.
- 160 A2. Fall River, West Virginia.

161. Monongahela River, Pennsylvania and West Virginia.
- 161 A. Youghiogheny River, Pennsylvania.
- 161 B. Dunkard's Creek, Pennsylvania.
  - 161 C. Meadow River, Pennsylvania.
  - 161 D. Big River, Pennsylvania.
  - 161 E. Shanon's River, Pennsylvania.
  - 161 F. Doll's River, West Virginia.
  - 161 G. Rudolph's River, Pennsylvania.
  - 161 H. Day's River, West Virginia.
  - 161 J. Merril's River, West Virginia.
  - 161 K. Hoover's River, Pennsylvania.
  - 161 L. Brown's River, West Virginia.
  - 161 M. Tom's River, Pennsylvania.
  - 161 N. Miracle River, West Virginia.
  - 161 O. North Fork of Monongahela River, West Virginia.
  - 161 P. Middle Fork of Monongahela River, West Virginia.
- 161 Q. Cheat River, Pennsylvania and West Virginia.
  - 161 Q*a*. Black Fork, West Virginia.
  - 161 Q*b*. Sandy Creek, West Virginia.
  - 161 R. Bell's River, West Virginia.
  - 161 S. Morgan's River, West Virginia.
  - 161 T. Quarry River, West Virginia.
  - 161 U. Bee River, West Virginia.
  - 161 V. Scott's River, West Virginia.
  - 161 W. Bull River, West Virginia.
  - 161 X. Big Sandy Creek, West Virginia.
  - 161 Y. Laurel River, West Virginia.
  - 161 Z. Green River, West Virginia.
  - 161 A2. Draper River, West Virginia.
  - 161 B2. Dougherty River, West Virginia.
  - 161 C2. Buffalo River, West Virginia.
  - 161 D2. Hefter River, West Virginia.
  - 161 E2. Mill River, West Virginia.
  - 161 F2. Horseshoe River, West Virginia.
  - 161 G2. Wolf River, West Virginia.

161. Monongahela River, Pennsylvania and West Virginia—Continued.

161 H2. Shaver's or Main Cheat River, West Virginia.
161 J2. Glade Fork of Cheat River, West Virginia.
161 K2. Laurel Fork of Cheat River, West Virginia.
161 L2. Dry Fork of Cheat River, West Virginia.
161 M2. Laurel River, West Virginia.
161 N2. Scott River, West Virginia.
161 O2. Meadow River, West Virginia.
161 P2. Tom's River, West Virginia.
161 Q2. Morgan's River, West Virginia.
161 R2. Buffalo Creek, West Virginia.
161 S2. Laurel River, West Virginia.
161 T2. Plumb River, West Virginia.
161 U2. Gray's River, West Virginia.
161 V2. McMahon's River, West Virginia.
161 W2. Salt Lick River, West Virginia.
161 X2. Flag River, West Virginia.
161 Y2. Piles Fork of Buffalo Creek, West Virginia.
161 Z2. Drake's River, West Virginia.
161 A3. Dent's River, West Virginia.
161 B3. Owing's Fork of Buffalo Creek, West Virginia.
161 C3. Clay Fork of Buffalo Creek, West Virginia.
161 D3. Lick River, West Virginia.
161 E3. West Fork of Monongahela River, West Virginia.
161 E3*a*. Hacker's Creek, West Virginia.
161 E3*b*. Polk Creek, West Virginia.
161 E3*c*. Stone Coal Creek, West Virginia
161 F3. Helen River, West Virginia.
161 G3. Robinson's River, West Virginia.
161 H3. Gregory's River, West Virginia.
161 J3. Rock Camp River, West Virginia.
161 K3. Grassy or North Fork of West Fork, West Virginia.
161 L3. Lambert's River, West Virginia.
161 M3. Jack's River, West Virginia.
161 N3. Davidson's River, West Virginia.
161 O3. Reid's River, West Virginia.
161 P3. Cowplin's River, West Virginia.
161 Q3. Hoe River, West Virginia.
161 R3. Maxwell River, West Virginia.
161 S3. Rush River, West Virginia.
161 T3. Carrion River, West Virginia.
161 U3. East Fork of Monongahela River, West Virginia.
161 V3. Grici's River, West Virginia.
161 W3. Laurel River, West Virginia.
161 X3. Lost River, West Virginia.

161. Monongahela River, Pennsylvania and West Virginia—Continued.
161 Y3. Bartlett's River, West Virginia.
161 Z3. Sand River, West Virginia.
161 A4. Mitchell's River, West Virginia.
161 B4. Mill River, West Virginia.
161 C4. Cades River, West Virginia.
161 D4. Tygart's Valley River, West Virginia.
161 D4*a*. Buckhannon River, West Virginia.
161 E4. Middle Fork of Tygart's Valley River, West Virginia.
161 F4. Phillis River, West Virginia.
161 G4. Riffle's River, West Virginia.
161 H4. Becky's River, West Virginia.
161 J4. Buchanon River, West Virginia.
161 K4. First Big River, West Virginia.
161 L4. Lick Shoal River, West Virginia.
161 M4. Regert's River, West Virginia.
161 N4. Peck's River, West Virginia.
161 O4. Handy Camp River, West Virginia.
161 P4. Big Sand River, West Virginia.
161 Q4. Turkey River, West Virginia.
161 R4. Fink's River, West Virginia.
161 S4. Ratcliffe's River, West Virginia.
161 T4. Little Sand River, West Virginia.
161 U4. Cutright River, West Virginia.
161 V4. Grand Camp River, West Virginia.
161 W4. Panther River, West Virginia.
161 X4. Left-hand River, West Virginia.

162. Big Muddy River, Illinois.
162 A. Kingkaid Creek, Illinois.
162 B. Beaucoup Creek, Illinois.
162 C. Pipestone Creek, Illinois.
162 D. Galum Creek, Illinois.
162 E. Little Beaucoup Creek, Illinois.
162 F. Swanwick Creek, Illinois.
162 G. Locust Creek, Illinois.
162 H. Painter Creek, Illinois.
162 J. Big Crab Orchard Creek, Illinois.
162 K. Crab Orchard Creek, Illinois.
162 L. Little Muddy River, Illinois.
162 M. Carson Creek, Illinois.
162 N. Middle Fork of Big Muddy River, Illinois.
162 O. Ewing's Creek, Illinois.
162 P. Gun Creek, Illinois.
162 Q. Casey Fork, Illinois.
162 R. Atchison's Creek, Illinois.
162 S. Ray's Creek, Illinois.

163. Kaskaskia River, Illinois.
163 A. Nine-mile Creek, Illinois.
163 B. Plumb Creek, Illinois.
163 C. Silver Creek, Illinois.
163 D. East Fork, Illinois.
163 E. Big Muddy Creek, Illinois.
163 F. Elk-horn Creek, Illinois.
163 G. Sugar Creek, Illinois.
163 H. Shoal Creek, Illinois.
163 J. Beaver Creek, Illinois.
163 K. Flat Branch, Illinois.
163 L. East Fork of Shoal Creek, Illinois.
163 M. Dry Creek, Illinois.
163 N. Middle Fork of Shoal Creek, Illinois.
163 O. West Fork of Shoal Creek, Illinois.
163 P. Crooked Creek, Illinois.
163 Q. Lost Creek, Illinois.
163 R. Great Point Creek, Illinois.
163 S. Prairie Creek, Illinois.
163 T. Cole's Creek, Illinois.
163 U. Gibbs Creek, Illinois.
163 V. East Fork of Kaskaskia River, Illinois.
163 W. Bear Creek, Illinois.
163 X. Hurricane Creek, Illinois.
163 Y. Hickory Creek, Illinois.
163 Z. Camp Creek, Illinois.
163 A2. Boaz Creek, Illinois.
163 B2. Suck Creek, Illinois.
163 C2. Big Creek, Illinois.
163 D2. Beck's Creek, Illinois.
163 E2. Richland Creek, Illinois.
163 F2. Brush Creek, Illinois.
163 G2. Robinson Creek, Illinois.
163 H2. Sand Creek, Illinois.
163 J2. West Fork of Kaskaskia River, Illinois.
163 K2. Apple Creek, Illinois.
163 L2. Lake Fork, Illinois.
164. Missouri River, Missouri, Kansas, Iowa, Nebraska, Colorado, Dakota, Montano, and Wyoming.
164*a*. Cuivre River, Missouri.
164 A. Gasconade River, Missouri.
164 B. Piney Fork of Gasconade River, Missouri.
164 B*a*. Auxvasse Creek, Missouri.
164 C. Osage River, Missouri and Kansas.
164 D. Loose Creek, Missouri.
164 D*a*. Niangua River, Missouri.

164. Missouri River, Missouri, Kansas, Iowa, &c.—Continued.

164 E. Grand River, Missouri.
164 F. Sac River, Missouri.
164 G. Little Osage River, Missouri and Kansas.
164 H. Marmiton River, Kansas.
164 H*a*. Drywood Creek, Missouri.
164 H*b*. Marais des Cygnes River, Kansas.
164 J. Pottawatomie Creek, Kansas.
164 K. South Fork of Pottawatomie Creek, Kansas.
164 K*a* Moniteau Creek, Missouri.
164 K*b*. Moreau Creek, Missouri.
164 L. Black Fork River, Missouri.
164 M. Salt Fork, Missouri.
164 N. Chariton River, Missouri and Iowa.
164 O. Muscle River, Missouri.
164 P. Walnut Creek, Iowa.
164 Q. South Chariton River, Iowa.
164 R. Wolf Creek, Iowa.
164 S. White Breast Creek, Iowa.
164 T. Grand River, Missouri and Iowa.
164 U. Locust Creek, Missouri.
164 V. Medicine River, Missouri.
164 V*a*. Shoal Creek, Missouri.
164 W. Welden River, Missouri.
164 X. West Fork of Grand River, Missouri.
164 Y. Twelve-mile Creek, Iowa.
164 Z. Four-mile Creek, Iowa.
164 A2. Three-mile Creek, Iowa.
164 A2*a*. Wakenda River, Missouri.
164 A2*b*. Moss Creek.
164 B2. KANSAS RIVER, Kansas, *vide* 165.
164 C2. Platte River, Missouri.
164 C2*a*. One-hundred-and-two River, Missouri.
164 D2. West Fork River, Iowa.
164 E2. Middle Fork River, Iowa.
164 F2. East Fork River, Iowa.
164 G2. Hçcey Creek, Iowa.
164 H2. East Platte River, Iowa.
164 J2. Nodaway River, Missouri and Iowa.
164 K2. East Nodaway River, Iowa.
164 L2. Middle Nodaway River, Iowa.
164 M2. West Nodaway River, Iowa.
164 N2. William's Branch, Iowa.
164 O2. Seven-mile Creek, Iowa.

164. Missouri River, Missouri, Kansas, Iowa, &c.—Continued.

164 P2. Big Tarkio Creek, Missouri and Iowa.
164 Q2. West Tarkio River, Missouri and Iowa.
164 R2. East Tarkio River, Iowa.
164 S2. Little Nemaha River, Nebraska.
164 T2. Nishnebotene River, Missouri and Iowa.
164 U2. Cooper Creek, Iowa.
164 V2. Mill Creek, Iowa.
164 W2. East Nishnebotene River, Iowa.
164 X2. Indian Creek, Iowa.
164 Y2. Turkey Creek, Iowa.
164 Z2. Buck Creek, Iowa.
164 A3. Crooked Creek, Iowa.
164 B3. Davis Creek, Iowa.
164 C3. Blue Grass Creek, Iowa.
164 D3. West Nishnebotene River, Iowa.
164 E3. Walnut Creek, Iowa.
164 F3. Indian Creek, Iowa.
164 G3. Silver Creek, Iowa.
164 H3. Middle Silver Creek, Iowa.
164 J3. Gray Bill Creek, Iowa.
164 K3. East Fork of West Nishnebotene River, Iowa.
164 L3. West Fork of West Nishnebotene River, Iowa.
164 M3. Keg Creek, Iowa.
164 N3. Poney Creek, Iowa.
164 O3. PLATTE RIVER, Nebraska, *vide* 166.
164 P3. Mosquito Creek, Iowa.
164 Q3. Pigeon Creek, Iowa.
164 R3. Potato Creek, Iowa.
164 S3. Boyer River, Iowa,
164 T3. Honey Creek, Iowa.
164 U3. Willow Creek, Iowa.
164 V3. Allen Creek, Iowa.
164 W3. Six-Mile Creek, Iowa.
164 X3. Mill Creek, Iowa.
164 Y3. Six-Mile Creek, Iowa.
164 Z3. East Boyer River, Iowa.
164 A4. Otter Creek, Iowa.
164 B4. Wall Lake, Iowa.
164 C4. Soldier River, Iowa.
164 D4. Morway Creek, Iowa.
164 E4. East Soldier River, Iowa.
164 F4. Middle Soldier River, Iowa.
164 G4. Beaver Creek, Iowa.

164. Missouri River, Missouri, Kansas, Iowa, &c.—Continued.

164 H4. LITTLE SIOUX RIVER, Iowa, *vide* 167.
164 J4. Floyd River, Iowa.
164 K4. Plymouth Creek, Iowa.
164 L4. Beaver Creek, Iowa.
164 M4. Willow Creek, Iowa.
164 N4. Deep Creek, Iowa.
164 O4. Perry Creek, Iowa.
164 P4. BIG SIOUX RIVER, Iowa, *vide* 168.
164 Q4. Vermillion River, Dakota.
164 R4. Turkey Ridge Creek, Dakota.
164 S4. Boisleger Lake, Dakota.
164 T4. Thompson Lake, Dakota.
164 U4. Bow Creek, Nebraska.
164 V4. Beaver Creek, Nebraska.
164 W4. James or Dakota River, Dakota.
164 X4. Black Earth Creek, Dakota.
164 Y4. Red Stone Creek, Dakota.
164 Z4. Morse's Creek, Dakota.
164 A5. Sand Creek, Dakota.
164 B5. Dead Ree Creek, Dakota.
164 C5. Muddy River, Dakota.
164 D5. Chedi Lake, Dakota.
164 E5. Tchanchicaha River, Dakota.
164 F5. Two Forks, Dakota.
164 G5. Grizzly Bear Creek, Dakota.
164 H5. Pipe Stone River, Dakota.
164 J5. Timber Spirit Wood Lake, Dakota.
164 K5. James River, Dakota.
164 L5. Niobrara River, Nebraska.
164 M5. Keya Paha River, Nebraska.
164 N5. Long Pine Creek, Nebraska.
164 O5. Mini Chaduza West or Rapid Creek, Nebraska.
164 P5. Snake River, Nebraska.
164 Q5. Boardman's Creek, Nebraska.
164 R5. Clay Creek, Nebraska.
164 S5. Antelope Creek, Nebraska.
164 T5. Rush Creek, Nebraska.
164 U5. Pine Creek, Nebraska.
164 V5. Rapid River, Nebraska.
164 W5. L'Eau Qui Court, Nebraska.
164 X5. Niorbrara River., Wyoming.
164 Y5. Choteau Creek, Dakota.
164 Z5. Garden Creek, Dakota.
164 A6. Scalp Creek, Dakota.
164 B6. Whetstone Creek, Dakota.

164. Missouri River, Missouri, Kansas, Iowa, &c.—Continued.

164 C6. Pratt Creek, Dakota.
164 D6. Waterholes Creek, Dakota.
164 E6. WHITE RIVER, Dakota, *vide* 169.
164 F6. American Crow Creek, Dakota.
164 G6. American Creek, Dakota.
164 H6. Soldier Creek, Dakota.
164 J6. Rock Creek, Dakota.
164 K6. La Chapelle Creek, Dakota.
164 L6. Medicine River, Dakota.
164 M6. Cedar Creek, Dakota.
164 N6. Medicine Knoll River, Dakota.
164 O6. Cabri or Antelope Creek, Dakota.
164 P6. Pawnee's Deserted Creek, Dakota.
164 Q6. Bad River, Dakota.
164 R6. Willow Creek, Dakota.
164 S6. Frozen Man's Creek, Dakota.
164 T6. Waterholes Creek, Dakota.
164 U6. La Chapaille Creek, Dakota.
164 V6. Wak Pa Shicha River, Dakota.
164 W6. Aricaree Creek, Dakota.
164 X6. Mitchell's Creek, Dakota.
164 Y6. Big Cottonwood Creek, Dakota.
164 Z6. Grindstone Creek, Dakota.
164 A7. Spring Creek, Dakota.
164 B7. Okoboju Creek, Dakota.
164 C7. BIG CHEYENNE RIVER, Dakota, *vide* 170.
164 D7. Inyan Tonka Water, Dakota.
164 E7. Assinniboine Creek, Dakota.
164 F7. Little Cheyenne or Cut-head River, Dakota.
164 G7. Swan Lake Creek, Dakota.
164 H7. Moreau River, Dakota.
164 J7. Little Moreau River, Dakota.
164 K7. Heecha River, Dakota.
164 L7. Owl River, Dakota.
164 M7. Bois Cache Creek, Dakota.
164 N7. Grand River Dakota.
164 O7. Palanata Wapka Ree River, Dakota.
164 P7. Hidden Wood Creek, Dakota.
164 Q7. South Fork of Grand River, Dakota.
164 R7. North Fork of Grand River, Dakota.
164 S7. Buffalo Creek, Dakota.
164 T7. Lightning Creek, Dakota.
164 U7. Ramnart Creek, Dakota.
164 V7. Bordache Creek, Dakota.
164 W7. Kitchisapi or Battle Creek, Dakota.

164. Missouri River, Missouri, Kansas, Iowa, &c.—Continued.

164 X7. Beaver Creek, Dakota.
164 Y7. Sand Creek, Dakota.
164 Z7. Pointer Creek, Dakota.
164 A8. Cannonball River, Dakota.
164 B8. North Fork of Cannonball River, Dakota.
164 C8. Dog's Teeth Creek, Dakota.
164 D8. Chanta Peta Creek, Dakota.
164 E8. Head of Cannonball River, Dakota.
164 F8. Cedar Creek, or South Fork of Cannonball River, Dakota.
164 G8. White Horse Creek, Dakota.
164 H8. Long Lake Creek, and Long Lake, Dakota.
164 J8. Apple Creek, Dakota.
164 K8. Buck Creek, Dakota.
164 L8. Heart River, Dakota.
164 M8. Sweet Brier Creek, Dakota.
164 N8. Mud Creek, Dakota.
164 O8. Square Butte Creek, Dakota.
164 P8. Burn's Creek, Dakota.
164 Q8. Painted Wood Creek, Dakota.
164 R8. Big Knife River, Dakota.
164 S8. Dry Lake, Dakota.
164 T8. Snake Creek, Dakota.
164 U8. Douglass Creek, Dakota.
164 V8. Beaver Creek, Dakota.
164 W8. Dancing Bear Creek, Dakota.
164 X8. Little Missouri River, Dakota and Montana.
164 Y8. Davis Creek, Dakota.
164 Z8. White Butte Creek, Dakota.
164 A9. Box Elder Creek, Dakota.
164 B9. Cold Spring Lake, Dakota.
164 C9. Shell Creek, Dakota.
164 D9. Little Knife Creek, Dakota.
164 E9. White Earth River, Dakota.
164 F9. Dry Fork Creek, Dakota.
164 G9. Red Bottom Creek, Dakota.
164 H9. Sandy Creek, Dakota.
164 J9. Red Bank Creek, Dakota.
164 K9. Fish Creek, Dakota.
164 L9. Painted Wood Creek, Dakota.
164 M9. YELLOWSTONE RIVER, Dakota and Montana, *vide* 171.
164 N9. Elk Lake, Dakota.
164 O9. Little Muddy Creek, Montana.
164 P9. Horse-Tied Creek, Montana.

164. Missouri River, Missouri, Kansas, Iowa, &c.—Continued.

164 Q9. Park River, Montana.
164 R9. Red Water Creek, Montana.
164 S9. Quaking Ash Creek, Montana.
164 T9. Rolling Branch, Montana.
164 U9. Tooley Creek, Montana.
164 V9. Wolf Creek, Montana.
164 W9. Elk Prairie Creek, Montana.
164 X9. Little Porcupine Creek, Montana.
164 Y9. MILK RIVER, Montana, *vide* 172.
164 Z9. Big Dry Creek, Montana.
164 A10. Timber Creek, Montana.
164 B10. Quarrel Creek, Montana.
164 C10. Pouchelle Creek, Montana.
164 D10. Squaw Creek, Montana.
164 E10. MUSSELSHELL RIVER, Montana, *vide* 173.
164 F10. Little Rocky Mountain Creek, Montana.
164 G10. Amell's Creek, Montana.
164 H10. Cow Island Creek, Montana.
164 J10. Birch Creek, Montana.
164 K10. Dog River, Montana.
164 L10. Judith River, Montana.
164 M10. West Fork, Montana.
164 N10. Divide Creek, Montana.
164 O10. Cottonwood Creek, Montana.
164 P10. Big Spring Branch, Montana.
164 Q10. Barren Creek, Montana.
164 R10. Dry Fork of Judith River, Montana.
164 S10. Trout Creek, Montana.
164 T10. Adam's Creek, Montana.
164 U10. Arrow River, Montana.
164 V10. Eagle Creek, Montana.
164 W10. Sandy Creek, Montana.
164 X10. Marias River, Montana.
164 Y10. Breast or Teton River, Montana.
164 Z10. Miry Bottom Fork, Montana.
164 A11. Gravel Bottom Fork, Montana.
164 B11. De Rouzer Creek, Montana.
164 C11. Birch Creek, Montana.
164 D11. Badger Creek, Montana.
164 E11. Cut Bank River, Montana.
164 F11. Cottonwood Creek, Montana.
164 G11. Badger River, Montana.
164 H11. Cottonwood Fork, Montana.
164 J11. Shonkin Creek, Montana.
164 K11. Highwood Creek, Montana.

164. Missouri River, Missouri, Kansas, Iowa, &c.—Continued.
164 L11. Belt Mountain Creek, Montana.
164 M11. Sun River, Montana.
164 N11. Muddy Creek, Montana.
164 O11. Medicine or Sun River, Montana.
164 P11. Elk Fork, Montana.
164 Q11. Deep Creek, Montana.
164 R11. Dog Creek, Montana.
164 S11. Eagle Creek, Montana.
164 T11. Sheep Creek, Montana.
164 U11. White Tail Deer Creek, Montana.
164 V11. Beaver Creek, Montana.
164 W11. Benton Creek, Montana.
164 X11. Thompson's Creek, Montana.
164 Y11. Dearborn River, Montana.
164 Z11. Beaver Creek, Montana.
164 A12. South Fork, Montana.
164 B12. Middle Fork, Montana.
164 C12. Little Prickly Pear River, Montana.
164 D12. Big Prickly Pear River, Montana.
164 E12. Silver Creek, Montana.
164 F12. Ten-Mile Creek, Montana.
164 G12. Boomerang Creek, Montana.
164 H12. Hyora Creek, Montana.
164 J12. Cataract Creek, Montana.
164 K12. Basin Creek, Montana.
164 L12. Red Rock Creek, Montana.
164 M12. Soap Creek, Montana.
164 N12. Trout Creek, Montana.
164 O12. Spokane Creek, Montana.
164 P12. Hellgate Creek, Montana.
164 Q12. White's Gulch, Montana.
164 R12. Beaver Creek, Montana.
164 S12. Confederate's Gulch, Montana.
164 T12. Duck Creek, Montana.
164 U12. North Creek, Montana.
164 V12. South Creek, Montana.
164 W12. Indian Creek, Montana.
164 X12. Deep Creek, Montana.
164 Y12. Greyson's Creek, Montana.
164 Z12. Crow Creek, Montana.
164 A13. Warm Spring Creek, Montana.
164 B13. Green River or Sixteen-mile Creek, Montana.
164 C13. East Gallatin River, Montana.
164 D13. Middle Creek, Montana.
164 E13. Bridger's Creek, Montana.

164. Missouri River, Missouri, Kansas, Iowa, &c.—Continued.

164 F13. Mill Creek, Montana.
164 G13. West Gallatin River, Montana.
164 H13. Madison River, Montana.
164 J13. Cherry Creek, Montana.
164 K13. Meadow Creek, Montana.
164 L13. Jourdan Creek, Montana.
164 M13. Jackass Creek, Montana.
164 N13. Cedar Creek, Montana.
164 O13. Bear Creek, Montana.
164 P13. Ruby Creek, Montana.
164 Q13. Indian Creek, Montana.
164 R13. Wall Creek, Montana.
164 S13. Second Standard Creek, Montana.
164 T13. West Fork, Montana.
164 U13. Fire Hole River, Montana and Wyoming.
164 V13. East Fork, Montana.
164 W13. Jefferson River,* Montana.
164 X13. Willow Creek, Montana.
164 Y13. North Boulder Creek, Montana.
164 Z13. South Boulder Creek, Montana.
164 A14. White-Tail Deer Creek, Montana.
164 B14. Pipestone Creek, Montana.
164 C14. Little Pipestone Creek, Montana.
164 D14. Hell Cañon Creek, Montana.
164 E14. Wisconsin Creek, Montana.
164 F14. Rochester Creek, Montana.
164 G14. Wisdom or Big-hole River, Montana.
164 H14. Birch Creek, Montana.
164 J14. Camp Creek, Montana.
164 K14. Moose Creek, Montana.
164 L14. Trapper Creek, Montana.
164 M14. Divide Creek, Montana.
164 N14. Fox Creek, Montana.
164 O14. French Creek, Montana.
164 P14. Pioneer Gulch, Montana.
164 Q14. Ruby River, Montana.
164 R14. Mill Creek, Montana.
164 S14. Alder Creek, Montana.
164 T14. Rattlesnake Creek, Montana.
164 U14. Black Tail Deer Creek, Montana.
164 V14. Horse Plain Creek, Montana.
164 W14. Red Rock Creek, Montana.
164 X14. Red Rock Lake, Montana.

*NOTE.—The Missouri River is formed by three streams, the Jefferson, the Madison, and the Gallatin, which unite in 45° 50′ north latitude and 111° 25′ west longitude.

165. Kansas River, Kansas (A chief tributary of Missouri River).

165 A. Stranger River, Kansas.

165 B. Wakarusa River, Kansas.

165 C. Grasshopper River, Kansas.

165 D. Rock Creek, Kansas.

165 E. Craig's Creek, Kansas.

165 F. Muddy Creek, Kansas

165 G. Soldier Creek, Kansas.

165 H. Cross Creek, Kansas.

165 J. Vermillion Creek, Kansas.

165 K. Rock Creek, Kansas.

165 L. Camp Creek, Kansas.

165 M. Big Blue River, Kansas and Nebraska.

165 N. Little Blue River, Kansas and Nebraska.

165 O. Elk Creek, Nebraska.

165 P. Morehead Creek, Nebraska.

165 Q. Thirty-two Mile Creek, Nebraska.

165 R. North Fork of Big Blue River, Nebraska.

165 S. Republican River, Kansas and Nebraska.

165 T. Buffalo Creek, Kansas.

165 U. White Rock Creek, Kansas.

165 V. Dog Creek, Kansas and Nebraska.

165 W. Tom-cat Creek, Kansas.

165 X. Sappa Creek, Kansas and Nebraska.

165 Y. Beaver Creek, Kansas and Nebraska.

165 Z. Little Beaver Creek, Kansas.

165 A2. North Fork of Sappa Creek, Kansas.

165 B2. South Fork of Sappa Creek, Kansas.

165 C2. Spring Creek, Nebraska.

165 D2. Elm Creek, Nebraska.

165 E2. Turkey Creek, Nebraska.

165 F2. Spring Creek, Nebraska.

165 G2. Stinking Water Creek, Nebraska.

165 H2. Medicine Creek, Nebraska.

165 J2. Beaver Creek, Nebraska.

165 K2. Fox Creek, Nebraska.

165 L2. North Fork of Medicine Creek, Nebraska.

165 M2. South Fork of Medicine Creek, Nebraska.

165 N2. Red Willow Creek, Nebraska.

165 O2. Blackwood Creek, Nebraska.

165 P2. North Fork of Republican River, Nebraska.

165 Q2. Palisade Creek, Nebraska.

165 R2. Spring Creek, Nebraska.

165 S2. Stinking Water Creek, Nebraska.

165. Kansas River, Kansas—Continued.

165 T2. Whiteman or Frenchman's Fork, Colorado.
165 U2. Camp Creek, Nebraska.
165 V2. Indian Creek, Nebraska.
165 W2. Rock Fork of Republican River, Nebraska.
165 X2. Arickaree or Bobtail Creek, Nebraska, Kansas, and Colorado.
165 Y2. Chief Creek, Nebraska.
165 Z2. Black Tail Creek, Colorado.
165 A3. Thickwood Creek, Kansas.
165 B3. Whetstone Creek, Colorado.
165 C3. Headwaters of Republican Fork, Colorado.
165 D3. Delaware or South Fork, Colorado.
165 E3. Chapman's Creek, Kansas.
165 F3. Mud Creek, Kansas.
165 G3. Solomon River, Kansas.
165 H3. South Fork of Solomon River, Kansas.
165 J3. North Fork of Solomon River, Kansas.
165 K3. Bow Creek, Kansas.
165 L3. Smoky Hill River, Kansas.
165 M3. Saline River, Kansas.
165 N3. Salt Creek, Kansas.
165 O3. Eagle Tail Creek, Kansas.
165 P3. Big Creek, Kansas.
165 Q3. North Fork of Big Creek, Kansas.
165 R3. Castle Rock Creek, Kansas.
165 S3. Huckleberry Creek, Kansas.
165 T3. Punished Woman Fork, Kansas.
165 U3. Twin Butte Creek, Kansas.
165 V3. Huckleberry Creek, Kansas.
165 W3. Poison Creek, Kansas and Colorado.
165 X3. North Fork of Smoky River, Kansas.
165 Y3. South Fork of Smoky River, Kansas and Colorado.
165 Z3. Little Turkey Creek, Kansas.
165 A4. Rose Creek, Kansas.
165 B4. Goose Creek, Kansas.

166. Platte River, Nebraska (a chief tributary of the Missouri River).

166 A. Cottonwood Creek, Nebraska.
166 B. Elkhorn River, Nebraska.
166 C. Belle Creek, Nebraska.
166 D. Maple Creek, Nebraska.
166 E. Logan River, Nebraska.
166 F. Middle Creek, Nebraska.
166 G. Union Creek, Nebraska.

166. Platte River, Nebraska—Continued.

166 H. North Branch of Elkhorn River, Nebraska.
166 J. Cedar Creek, Nebraska.
166 K. Cache Creek, Nebraska.
166 L. South Fork of Elkhorn River, Nebraska.
166 M. Shell Creek, Nebraska.
166 N. Loup River, Nebraska.
166 O. Beaver Creek, Nebraska.
166 P. Cedar Creek, Nebraska.
166 Q. North Fork of Loup River, Nebraska.
166 R. Calamus Creek, Nebraska.
166 S. Middle Fork of Loup River, Nebraska.
166 T. Dismal River, Nebraska.
166 U. South Fork of Loup River, Nebraska.
166 V. North Fork of Platte River, Nebraska.
166 W. Ash Creek, Nebraska.
166 X. Rush Creek, Nebraska.
166 Y. Bluewater Creek, Nebraska.
166 Z. Coldwater Creek, Nebraska.
166 A2. Smith's Fork, Nebraska.
166 B2. Dry Fork, Nebraska.
166 C2. Horse Creek, Nebraska and Wyoming.
166 D2. Dry Creek, Nebraska and Wyoming.
166 E2. Cherry Creek, Nebraska and Wyoming.
166 F2. South Fork, Wyoming.
166 G2. Spoonbill Creek, Wyoming.
166 H2. Rawhide Creek, Wyoming.
166 J2. Laramie River, Wyoming.
166 K2. Chugwater Creek, Wyoming.
166 L2. Whiskey Creek, Wyoming.
166 M2. Horseshoe Creek, Wyoming.
166 N2. Rio La Boute, Wyoming.
166 O2. Spring Creek, Wyoming.
166 P2. Rio de la Prete, Wyoming.
166 Q2. Boisee River, Wyoming.
166 R2. Deer Creek, Wyoming.
166 S2. Poison Spring Creek, Wyoming.
166 T2. Willow Creek, Wyoming.
166 U2. Sweetwater River, Wyoming.
166 V2. Horse Creek, Wyoming.
166 W2. Medicine Bow River, Wyoming.
166 X2. South Fork of North Platte River, Colorado.
166 Y2. South Platte River, Colorado.
166 Z2. Lewis Creek, Colorado.
166 A3. Horse Tail Creek, Colorado.
166 B3. Pawnee Creek, Colorado.

166. Platte River, Nebraska—Continued.

166 C3. Beaver Creek, Colorado.
166 D3. Antelope Creek, Colorado.
166 E3. Bijou Creek, Colorado.
166 F3. Deer Tail Creek, Colorado.
166 G3. East Bijou Creek, Colorado.
166 H3. Middle Bijou Creek, Colorado.
166 J3. Kiowa Creek, Colorado.
166 K3. Comanche Creek, Colorado.
166 L3. Wolf Creek, Colorado.
166 M3. Lost Spring Creek, Colorado.
166 N3. Terrapin, or Box Elder Creek, Colorado.
166 O3. Crow Creek, Colorado.
166 P3. Cache La Poudre Creek, Colorado.
166 Q3. Lone Tree Creek, Colorado.
166 R3. Box Elder Creek, Colorado.
166 S3. Dale Creek, Colorado.
166 T3. Big Thompson Creek, Colorado.
166 U3. Little Thompson Creek, Colorado.
166 V3. Saint Vrain's Creek, Colorado.
166 W3. Coal Creek, Colorado.
166 X3. Cherry Creek, Colorado.
166 Y3. Willow Creek, Colorado.
166 Z3. Bear Creek, Colorado.
166 A4. Plum Creek, Colorado.
166 B4. Deer Creek, Colorado.
166 C4. Brush Creek, Colorado.
166 D4. North Fork of South Platte River, Colorado.
166 E4. Buffalo Creek, Colorado.
166 F4. Elk Creek, Colorado.
166 G4. Deer Creek, Colorado.
166 H4. Pine Grove Creek, Colorado.
166 J4. East Fork of South Platte River, Colorado.
166 K4. Tarryall Creek, Colorado.
166 L4. Four-Mile Creek, Colorado.

167. Little Sioux River, Iowa (a chief tributary of the Missouri River).

167 A. Maple River, Iowa.
167 B. Beaver Creek, Iowa.
167 C. Battle Creek, Iowa.
167 D. Willow Creek, Iowa.
167 E. Odebott Creek, Iowa.
167 F. Elk Creek, Iowa.
167 G. Silver Creek, Iowa.
167 H. West Fork of Little Sioux River, Iowa.
167 J. Wolf Creek, Iowa.
167 K. East Fork of Little Sioux River, Iowa.

167. Little Sioux River, Iowa—Continued.
- 167 L. Elliot Creek, Iowa.
- 167 M. Big Whiskey Creek, Iowa.
- 167 N. Booth Creek, Iowa.
- 167 O. Clear Creek, Iowa.
- 167 P. Miller Creek, Iowa.
- 167 Q. Silver Creek, Iowa.
- 167 R. Mill Creek, Iowa.
- 167 S. Waterman Creek, Iowa.
- 167 T. Willow Creek, Iowa.
- 167 U. Elk Lake, Iowa.
- 167 V. Trumbull Lake, Iowa.
- 167 W. Meadow Branch, Iowa.
- 167 X. Ocheyedan River, Iowa.
- 167 Y. Spirit Lake, Iowa.
- 167 Z. Okoboji Lake, Iowa.
- 167 A2. Silver Lake, Iowa.

168. Big Sioux River, Iowa and Dakota (a chief tributary of the Missouri River).
- 168 A. Broken Kettle Creek, Iowa.
- 168 B. Westfield Creek, Iowa.
- 168 C. Indian Creek, Iowa.
- 168 D. Ford Creek, Iowa.
- 168 E. Rock River, Iowa.
- 168 F. Mud Creek, Iowa.
- 168 G. East Rock River, Iowa.
- 168 H. Otter Creek, Iowa.
- 168 J. Tom Creek, Iowa.
- 168 K. Pipestone Creek, Dakota and Minnesota.
- 168 L. Skunk Creek and Lake, Dakota.
- 168 M. Medway Creek, Dakota and Minnesota.
- 168 N. Lake Campbell, Dakota.
- 168 O. Lake Poinsett, Dakota.
- 168 P. Lake Kampeska, Dakota.

169. White River, Dakota (a chief tributary of Missouri River).
- 169 A. Bull Creek, Dakota.
- 169 B. South Fork, Dakota.
- 169 C. Rosebud Creek, Dakota.
- 169 D. Smoky Earth River, Dakota.
- 169 E. Bad Land Creek, Dakota.
- 169 F. Ponka Creek, Dakota.
- 169 G. Okiokendoka West, or Pass Creek, Dakota.
- 169 H. Makisata Wakpa River, Dakota.
- 169 J. Eagle Nest Creek, Dakota.
- 169 K. Corn Creek, Dakota.
- 169 L. Porcupine Tail Creek, Dakota.

169. White River, Dakota—Continued.
 169 M. White River, Dakota.
 169 N. Wounded Knee Creek, Dakota.
 169 O. White Earth Creek, Dakota.
 169 P. Guerrier's Creek, Nebraska.
 169 Q. East Labone Creek, Nebraska.
 169 R. Bad Hand Creek, Nebraska.
 169 S. Earth Lodge Creek, Nebraska.
 169 T. West Clay Creek, Nebraska.
170. Big Cheyenne River, Dakota (a chief tributary of Missouri River).
 170 A. Plum Creek, Dakota.
 170 B. Cherry Creek, Dakota.
 170 C. Wap-ka-washti, or Good River, Dakota.
 170 D. South Fork of Big Cheyenne River, Dakota.
 170 E. Bull Creek, Dakota.
 170 F. Elk Creek, Dakota.
 170 G. Sage Creek, Dakota.
 170 H. Bear Creek, Dakota.
 170 J. Box Elder Creek, Dakota.
 170 K. Rapid Creek, Dakota.
 170 L. Spring Creek, Dakota.
 170 M. French Creek, Dakota.
 170 N. Hat Creek, Dakota.
 170 O. Horsehead Creek, Dakota.
 170 P. Sage Creek, Wyoming.
 170 Q. West Fork, Wyoming.
 170 R. North Fork of Cheyenne River, Dakota and Wyoming.
 170 S. Bear Butte Creek, Dakota.
 170 T. Crow Creek, Dakota.
 170 U. Bell Fourche River, Dakota.
 170 V. Red Water Creek, Dakota and Wyoming.
171. Yellowstone River, Dakota and Montana (a chief tributary of Missouri River).
 171 A. Charbonneau Creek, Dakota.
 171 B. Fox Creek, Montana.
 171 C. Deer Creek, Montana.
 171 D. Glendive Creek, Montana.
 171 E. Cedar Creek, Montana.
 171 F. Cabin Creek, Montana.
 171 G. Sandy Creek, Montana.
 171 H. Plum Creek, Montana.
 171 J. O'Fallon's Creek, Montana.
 171 K. Powder River, Montana.
 171 L. Mizpah Creek, Montana.
 171 M. Little Powder River, Montana and Wyoming.
 171 N. Clear Fork, Wyoming and Montana.

171. Yellowstone River, Dakota and Montana—Continued.

171 O. Piney Fork, Wyoming.
171 P. Crazy Woman's Fork, Wyoming.
171 Q. Tongue River, Montana.
171 R. Pumpkin Creek, Montana.
171 S. Cheyenne Fork, Montana.
171 T. Little Tongue River, Montana.
171 U. Rosebud River, Montana.
171 V. Little Porcupine River, Montana.
171 W. Emmell's Creek, Montana.
171 X. Big Horn River, Montana.
171 Y. Tullock's Fork, Montana.
171 Z. Custer River, Montana.
171 A2. Grassy Lodge Creek, Montana.
171 B2. Pass Creek, Montana.
171 C2. Beaubois Fork, Montana.
171 D2. Rotten Grass Creek, Montana.
171 E2. Soap Creek, Montana.
171 F2. Stinking Water Creek, Wyoming.
171 G2. Sage Creek, Wyoming.
171 H2. Shell Creek, Wyoming.
171 J2. Grey Bull River, Wyoming.
171 K2. North Wood Creek, Wyoming.
171 L2. North Water Creek, Wyoming.
171 M2. Owl Creek, Wyoming.
171 N2. Bad Water Creek, Wyoming.
171 O2. Wind River, Wyoming.
171 P2. Popo Agie River, Wyoming.
171 Q2. Little Agie River, Wyoming.
171 R2. Arrow Creek, Montana.
171 S2. Pryor's River, Montana.
171 T2. Clarke's Fork, Montana and Wyoming.
171 U2. Rock Creek, Montana.
171 V2. Baudin's Fork, Montana.
171 W2. Big Willow Creek, Montana.
171 X2. Rosebud Creek, Montana.
171 Y2. Stillwater Creek, Montana.
171 Z2. Charles Creek, Montana.
171 A3. Big Deer Creek, Montana.
171 B3. Smut Grass Creek, Montana.
171 C3. Little Deer Creek, Montana.
171 D3. Medicine Bow Creek, Montana.
171 E3. Big Boulder River, Montana.
171 F3. Skull Creek, Montana.
171 G3. West Fork of Yellowstone River, Montana.
171 H3. Brackett's Creek, Montana.

171. Yellowstone River, Dakota and Montana—Continued.

171 J3. Trail Creek, Montana.
171 K3. Emigrant Creek, Montana.
171 L3. Six-Mile Creek, Montana.
171 M3. Bear Gulch, Montana.
171 N3. Gardner River, Montana and Wyoming.
171 O3. Black Tail Deer Creek, Wyoming.
171 P3. Crevice Gulch, Montana and Wyoming.
171 Q3. Hell Roaring River, Montana and Wyoming.
171 R3. Meadow Creek, Wyoming.
171 S3. East Fork of Yellowstone River, Wyoming.
171 T3. Slough Creek, Wyoming.
171 U3. Buffalo Creek, Wyoming.
171 V3. Sour Creek, Wyoming.
171 W3. Pelican Creek, Wyoming.
171 X3. Yellowstone Lake, Wyoming.
171 Y3. Upper Yellowstone River, Wyoming.
171 Z3. Bridger's Lake, Wyoming.

172. Milk River, Montana Territory (a chief tributary of Missouri River.)

172 A. Big Porcupine Creek, Montana.
172 B. Lime Creek, Montana.
172 C. Box Elder Creek, Montana.
172 D. Willow Creek, Montana.
172 E. Little Box Elder Creek, Montana.
172 F. Dry Creek, Montana.
172 G. Little Porcupine Creek, Montana.
172 H. Beaver Creek, Montana.
172 J. Frenchman's Creek, Montana.
172 K. Snake Creek, Montana.
172 L. Beaver Creek, Montana.
172 M. Dry Fork Creek, Montana.
172 N. People's Creek, Montana.
172 O. Twelve-Mile Creek, Montana.
172 P. Twenty-mile Creek, Montana.
172 Q. Dry Creek, Montana.
172 R. Two Forks, Montana.
172 S. Clear Creek, Montana.
172 T. Beaver Creek, Montana.
172 U. Box Elder Creek, Montana.

73. Musselshell River, Montana (a chief tributary of Missouri River).

173 A. Crow Creek, Montana.
173 B. Dovetail Creek, Montana.
173 C. Cat Creek, Montana.
173 D. Blood Creek, Montana.

173. Musselshell River, Montana—Continued.
173 E. Wood Creek, Montana.
173 F. North Fork, Montana.
173 G. Yellow Water Creek, Montana.
173 H. Box Elder Creek, Montana.
173 J. McDonald's Creek, Montana.
173 K. South Fork, Montana.
173 L. Swimming Woman Creek, Montana.
173 M. Careless Creek, Montana.
173 N. Fish Creek, Montana.
173 O. Willow Creek, Montana.
173 P. Indian Creek, Montana.
173 Q. North Fork, Montana.
173 R. Flat Head Creek, Montana.
173 S. South Fork, Montana.
174. Illinois River, Illinois.
174 A. Otter Creek, Illinois.
174 B. Macoupin Creek, Illinois.
174 C. Taylor's Creek, Illinois.
174 D. Joe's Creek, Illinois.
174 E. Solomon's Creek, Illinois.
174 F. Otter Creek, Illinois.
174 G. Bear Creek, Illinois.
174 H. Honey Creek, Illinois.
174 J. Apple Creek, Illinois.
174 K. Big Grassy Lake, Illinois.
174 L. Big Sandy Creek, Illinois.
174 M. Little Sandy Creek, Illinois.
174 N. Walnut Slough, Illinois.
174 O. Bay Creek, Illinois.
174 P. Mauvaise Terre Creek, Illinois.
174 Q. McKee's Creek, Illinois.
174 R. Willow Creek, Illinois.
174 S. Indian Creek, Illinois.
174 T. Prairie Creek, Illinois.
174 U. Crooked Creek, Illinois.
174 V. Little Missouri Creek, Illinois.
174 W. Cedar Creek, Illinois.
174 X. Grindstone Creek, Illinois.
174 Y. Carter's Creek, Illinois.
174 Z. Camp Creek, Illinois.
174 A2. Troublesome Creek, Illinois.
174 B2. Panther Creek, Illinois.
174 C2. Bronson's Creek, Illinois.
174 D2. Middle Creek, Illinois.
174 E2. Long Creek, Illinois.

174. Illinois River, Illinois—Continued.

174 F2. North Branch of Crooked Creek, Illinois.
174 G2. Spring Creek, Illinois.
174 H2. Sangamon River, Illinois.
174 J2. Big Panther's Creek, Illinois.
174 K2. Clary's Creek, Illinois.
174 L2. Crane Creek, Illinois.
174 M2. Salt River, Illinois.
174 N2. Prairie Creek, Illinois.
174 O2. Sugar Creek, Illinois.
174 P2. Kickapoo Creek, Illinois.
174 Q2. Deer Creek, Illinois.
174 R2. Salt Creek, Illinois.
174 S2. North Branch of Salt Creek, Illinois.
174 T2. Lake Fork of Salt Creek, Illinois.
174 U2. Rock Creek, Illinois.
174 V2. Spring Creek, Illinois.
174 W2. Lick Creek, Illinois.
174 X2. Sugar Creek, Illinois.
174 Y2. Brush Creek, Illinois.
174 Z2. South Fork, Illinois.
174 A3. Bear Creek, Illinois.
174 B3. Flat Branch, Illinois.
174 C3. Lake Fork, Illinois.
174 E3. Willow Branch, Illinois.
174 F3. Goose Creek, Illinois.
174 G3. Camp Creek, Illinois.
174 H3. Madden Creek, Illinois.
174 J3. Stevens Creek, Illinois.
174 K3. Otter Creek, Illinois.
174 L3. Spoon River, Illinois.
174 M3. Big Creek, Illinois.
174 N3. Putnam Creek, Illinois.
174 O3. Coal Creek, Illinois.
174 P3. Cedar Creek, Illinois.
174 Q3. Swan Creek, Illinois.
174 R3. French Creek, Illinois.
174 S3. Sugar Creek, Illinois.
174 T3. Walnut Creek, Illinois.
174 U3. Quiver Creek, Illinois.
174 V3. Bucklin Creek, Illinois.
174 W3. Mackinaw River, Illinois.
174 X3. Mill Creek, Illinois.
174 Y3. Walnut Creek, Illinois.
174 Z3. Panther Creek, Illinois.

174. Illinois River, Illinois—Continued.

174 A4. North West Branch of Mackinaw River, Illinois.
174 B4. East Branch of Mackinaw River, Illinois.
174 C4. Six-Mile Creek, Illinois.
174 D4. Money Creek, Illinois.
174 E4. Bray's Creek, Illinois.
174 F4. Henline Creek, Illinois.
174 G4. Kickapoo Creek, Illinois.
174 H4. Richland Creek, Illinois.
174 J4. Crow Creek, Illinois.
174 K4. North Branch of Crow Creek, Illinois.
174 L4. South Branch of Crow Creek, Illinois.
174 M4. Strown's River, Illinois.
174 N4. Crow Creek, Illinois.
174 O4. Sandy Creek, Illinois.
174 P4. Clear Creek, Illinois.
174 Q4. Big Bureau Creek, Illinois.
174 R4. East Bureau Creek, Illinois.
174 S4. West Bureau Creek, Illinois.
174 T4. Negro Creek, Illinois.
174 U4. Vermillion River, Illinois.
174 V4. Wolf Creek, Illinois.
174 W4. Otter Creek, Illinois.
174 X4. Scattering Point Creek, Illinois.
174 Y4. Rook's Creek, Illinois.
174 Z4. South Fork of Vermillion, Illinois.
174 A5. North Fork of Vermillion, Illinois.
174 B5. Covel Creek, Illinois.
174 C5. Fox River, Illinois.
174 D5. Big Indian Creek, Illinois.
174 E5. Indian Creek, Illinois.
174 F5. Mission Creek, Illinois.
174 G5. Somonauk Creek, Illinois.
174 H5. Battle Creek, Illinois.
174 J5. Blackberry Creek, Illinois.
174 K5. Fox Lake, Illinois.
174 L5. Squaw Creek, Illinois.
174 M5. Nipper Sink Lake and Creek, Illinois.
174 N5. Nettle Creek, Illinois.
174 O5. Waupecan Creek, Illinois.
174 P5. Mazon River, Illinois.
174 Q5. West Fork of Mazon River, Illinois.
174 R5. East Fork of Mazon River, Illinois.
174 S5. Gooseberry Creek, Illinois.
174 T5. Au Sable Creek, Illinois.

174. Illinois River, Illinois—Continued.

174 U5. Saratoga Creek, Illinois.
174 V5. Kankakee River, Illinois and Indiana.
174 W5. Prairie Creek, Illinois.
174 X5. Forked Creek, Illinois.
174 Y5. Rock Creek, Illinois.
174 Z5. Iroquois River, Illinois and Indiana.
174 A6. Langum River, Illinois.
174 B6. Prairie Creek, Illinois.
174 C6. Spring Creek, Illinois.
174 D6. Sugar Creek, Illinois.
174 E6. Carpenter Creek, Indiana.
174 F6. Big Slough, Indiana.
174 G6. Pickamink River, Indiana.
174 H6. Exline Slough, Illinois.
174 J6. Trim Creek, Illinois.
174 K6. English Lake, Indiana.
174 L6. Yellow River, Indiana.
174 M6. North Fork, Indiana.
174 N6. Mud Lake, Indiana.
174 O6. Du Page River, Illinois.
174 P6. Lilly Cache River, Illinois.
174 Q6. West Branch of Du Page River, Illinois.
174 R6. Jackson Creek, Illinois.
174 S6. Des Plaines River, Illinois.
174 T6. Calumet River, Illinois and Indiana.
174 U6. Little Calumet River, Illinois and Indiana.
174 V6. Salt Creek, Illinois.
174 W6. Mill Creek, Illinois.

175. Des Moines River, Iowa.

175 A. Jake West Creek, Iowa.
175 B. South Jake West Creek, Iowa.
175 C. South Soap Creek, Iowa.
175 D. Little Soap Creek, Iowa.
175 E. Avery Creek, Iowa.
175 F. White Breast River, Iowa.
175 G. Flank Creek, Iowa.
175 H. Watkin Creek, Iowa.
175 J. South River, Iowa.
175 K. Otter Creek, Iowa.
175 L. Squaw Creek, Iowa.
175 M. Mud Creek, Iowa.
175 N. Middle River, Iowa.
175 O. Clanton's Creek, Iowa.
175 P. North River, Iowa.
175 Q. Badger River, Iowa.

175. Des Moines River, Iowa—Continued.
- 175 R. North Branch of North River, Iowa.
- 175 S. Tom Creek, Iowa.
- 175 T. Yader Creek, Iowa.
- 175 U. Raccoon River, Iowa.
- 175 V. Walnut Creek, Iowa.
- 175 W. Sugar Creek, Iowa.
- 175 X. South Raccoon River, Iowa.
- 175 Y. Panther Creek and Pilot Lake, Iowa.
- 175 Z. Bear Creek, Iowa.
- 175 A2. Middle Raccoon River, Iowa.
- 175 B2. Mosquito Creek, Iowa.
- 175 C2. Willow Creek, Iowa.
- 175 D2. Beaver Creek, Iowa.
- 175 E2. Bushy Fork Creek, Iowa.
- 175 F2. East Fork of Buttrick Creek, Iowa.
- 175 G2. West Fork of Buttrick Creek, Iowa.
- 175 H2. Cedar Creek, Iowa.
- 175 J2. Purgatory Creek, Iowa.
- 175 K2. North Coon River, Iowa.
- 175 L2. Lake Creek, Iowa.
- 175 M2. Swan Creek, Iowa.
- 175 N2. Camp Creek, Iowa.
- 175 O2. Indian Creek, Iowa.
- 175 P2. Clear and Swan Lakes, Iowa.
- 175 Q2. Round and Storm Lakes, Iowa.
- 175 R2. Beaver Creek, Iowa.
- 175 S2. Slough Creek, Iowa.
- 175 T2. Boone River, Iowa.
- 175 U2. White Fox Creek, and Elm Lake, Iowa.
- 175 V2. Eagle Creek, Iowa.
- 175 W2. Owl Lake, Iowa.
- 175 X2. Otter Creek, Iowa.
- 175 Y2. Prairie Creek, Iowa.
- 175 Z2. North Lizzard Creek, Iowa.
- 175 A3. South Lizzard Creek, Iowa.
- 175 B3. Soldier Creek, Iowa.
- 175 C3. Beaver Creek, Iowa.
- 175 D3. East Fork of Des Moines River, Iowa.
- 175 E3. Bloody Creek, Iowa.
- 175 F3. Lott's Creek, Iowa.
- 175 G3. Four-Mile Creek, Iowa.
- 175 H3. Black Cat Creek, Iowa.
- 175 J3. Plumb Creek, Iowa.
- 175 K3. Buffalo Fork, Iowa.
- 175 L3. Blue Earth Creek, and Bancroft Lake, Iowa.

175. Des Moines River, Iowa—Continued.
175 M3. West Fork of Des Moines River, Iowa.
175 N3. Indian Creek, Iowa.
175 O3. Pilot Creek, Iowa.
175 P3. Beaver Creek, Iowa.
175 Q3. Willow Creek, Iowa.
175 R3. Medium Lake, Iowa.
175 S3. Jack Creek and Swan Lake, Iowa.
175 T3. Heron and Shetek Lakes, Minnesota.
176. Skunk River, Iowa.
176 A. Big Creek, Iowa.
176 B. Cedar Creek, Iowa.
176 C. South Skunk River, Iowa.
176 D. Indian Creek, Iowa.
176 E. East Indian Creek, Iowa.
176 F. West Indian Creek, Iowa.
176 G. Squaw Creek, Iowa.
176 H. Cairo and Iowa Lakes, Iowa.
176 J. North Skunk River, Iowa.
176 K. Coal Creek, Iowa.
176 L. Middle Creek, Iowa.
176 M. Rock Creek, Iowa.
176 N. Alloway Creek, Iowa.
177. Iowa River, Iowa.
177 A. Otter Creek, Iowa.
177 B. Long Creek, Iowa.
177 C. Cedar River, Iowa.
177 D. Sugar Creek, Iowa.
177 E. Prairie Creek, Iowa.
177 F. Dry Creek, Iowa.
177 G. Mud Creek, Iowa.
177 H. Pratt Creek, Iowa.
177 J. Lime Creek, Iowa.
177 K. Rock Creek, Iowa.
177 L. Big Creek, Iowa.
177 M. Twelve-Mile Creek, Iowa.
177 N. Wolf Creek, Iowa.
177 O. Miller's Creek, Iowa.
177 P. Ellsworth Creek, Iowa.
177 Q. Black Hawk Creek, Iowa.
177 R. North Fork of Black Hawk Creek, Iowa.
177 S. Dry Run, Iowa.
177 T. North Branch of Cedar River, Iowa.
177 U. Beaver Creek, Iowa.
177 V. Red Cedar River, Iowa.
177 W. Little Cedar River, Iowa.

177. Iowa River, Iowa—Continued.
- 177 X. Rock Creek, Iowa.
- 177 Y. Deer Creek, Iowa.
- 177 Z. West Fork of Cedar River, Iowa.
- 177 A2. Maynes Creek, Iowa.
- 177 B2. Dutchman's Creek, Iowa.
- 177 C2. Otter Creek, Iowa.
- 177 D2. Squaw Creek, Iowa.
- 177 E2. Spring Creek, Iowa.
- 177 F2. Shell Rock River, Iowa.
- 177 G2. Flood Creek, Iowa.
- 177 H2. Cold Water Creek, Iowa.
- 177 J2. Lime Creek, Iowa.
- 177 K2. Willow Creek and Clear Lake, Iowa.
- 177 L2. Winan's Creek and Rice Lake, Iowa.
- 177 M2. Beaver Creek, Iowa.
- 177 N2. Elk Creek, and Silver Lake, Iowa.
- 177 O2. Whiskey River, Iowa.
- 177 P2. South English River, Iowa.
- 177 Q2. Old Man's Creek, Iowa.
- 177 R2. North English River, Iowa.
- 177 S2. Clear Creek, Iowa.
- 177 T2. Price Creek, Iowa.
- 177 U2. Little Bear Creek, Iowa.
- 177 V2. Walnut Creek, Iowa.
- 177 W2. Salt Creek, Iowa.
- 177 X2. Richland Creek, Iowa.
- 177 Y2. Deer Creek, Iowa.
- 177 Z2. Raven Creek, Iowa.
- 177 A3. Timber Creek, Iowa.
- 177 B3. Burnett Creek, Iowa.
- 177 C3. Honey Creek, Iowa.
- 177 D3. South Fork of Iowa River, Iowa.
- 177 E3. East Fork of Iowa River, Iowa.
- 177 F3. Eagle and Crystal Lakes, Iowa.

178. Rock River, Illinois.
- 178 A. Mill Creek, Illinois.
- 178 B. Green River, Illinois.
- 178 C. Mineral Creek, Illinois.
- 178 D. Spring Creek, Illinois.
- 178 E. Mud Creek, Illinois.
- 178 F. Coal Creek, Illinois.
- 178 G. Hickory Creek, Illinois.
- 178 H. Willow Creek, Ilinois.

178. Rock River, Illinois—Continued.
- 178 J. Rock Creek, Illinois.
  - 178 K. Little Creek, Illinois.
- 178 L. Sugar Creek, Illinois.
  - 178 M. Spring Creek Illinois.
  - 178 N. Elkhorn Creek, Illinois.
- 178 O. Five-mile Creek, Illinois.
- 178 P. Three-mile Creek, Illinois.
- 178 Q. Pine Creek, Illinois.
- 178 R. Clear Creek, Illinois.
- 178 S. Kite River, Illinois.
- 178 T. Leaf River, Illinois.
- 178 U. Kishwaukee River, Illinois.
  - 178 V. Piseasaw Creek, Illinois.
  - 178 W. Coon Creek, Illinois.
  - 178 X. Rush Creek, Illinois.
- 178 Y. North Branch of Kent's Creek, Illinois.
- 178 Z. Pecatonica River, Illinois and Wisconsin.
  - 178 A2. Rock Run, Illinois.
  - 178 B2. Yellow Creek, Illinois.
- 178 C2. Sugar River, Illinois.
  - 178 D2. Otter Creek, Illinois.

179. Wapsipinicon River, Iowa.
- 179 A. Brophy's Creek, Iowa.
- 179 B. Sugar Creek Iowa.
- 179 C. Mud Creek, Iowa.
- 179 D. Buffalo Creek, Iowa.
- 179 E. Pine Creek, Iowa.
- 179 F. Birch Creek, Iowa.
- 179 G. Crane Creek, Iowa.
- 179 H. East Wapsipinicon River, Iowa.
- 179 J. Little Wapsipinicon River, Iowa.

180. Wisconsin River, Wisconsin.
- 180 A. Kickapoo River, Wisconsin.
- 180 B. Clover River Wisconsin.
- 180 C. Little Aux Plain River, Wisconsin.
- 180 D. Big Aux Plain River, Wisconsin.
- 180 E. Big Eau Claire River, Wisconsin.
  - 180 F. West Fork of Eau Claire River, Wisconsin.
  - 180 G. East Fork of Eau Claire River, Wisconsin.
- 180 H. Rib River, Wisconsin.
  - 180 J. Little Rib River, Wisconsin.
  - 180 K. Black Creek, Wisconsin.
- 180 L. Pine River, Wisconsin.
- 180 M. Prairie River, Wisconsin.
- 180 N. Devil River, Wisconsin.

180. Wisconsin River, Wisconsin—Continued.
- 180 O. Copper River, Wisconsin.
- 180 P. New Wood River, Wisconsin.
- 180 Q. Spirit River, Wisconsin.
- 180 R. Tomahawk River, Wisconsin.
  - 180 S. Snow River, Wisconsin.
  - 180 T. Willow Lake, Wisconsin.
  - 180 U. Squirrel Lake, Wisconsin.
  - 180 V. Mud Lake, Wisconsin.
  - 180 W. Tomahawk Lake, Wisconsin.
  - 180 X. Lake of Arbor Vitæ, Wisconsin.
- 180 Y. Pelican River, Wisconsin.
  - 180 Z. Pelican Lake, Wisconsin.
- 180 A2. Lakes Saint Germaine, Plum, Star, and Laura, Wisconsin.
- 180 B2. Eagle Lake, Twin Lakes and Lac Vieux Desert, Wisconsin.

181. Chippewa River, Wisconsin.
- 181 A. Plum Creek, Wisconsin.
- 181 B. Eau Galle River, Wisconsin.
- 181 C. Red Cedar River, Wisconsin.
  - 181 D. Hay River, Wisconsin.
    - 181 E. Tiffany Creek, Wisconsin.
    - 181 F. Turtle Creek, Wisconsin.
  - 181 G. Shetuk River, Wisconsin.
  - 181 H. Yellow River, Wisconsin.
  - 181 J. Bear Lake, Wisconsin.
  - 181 K. Little Bear Lake, Wisconsin.
  - 181 L. Red Cedar Lake, and Lake Chetac, Wisconsin.
  - 181 M. Summit Flat and Fish Lakes, Wisconsin.
- 181 N. Mud Creek, Wisconsin.
- 181 O. Elk Creek, Wisconsin.
- 181 P. Eau Claire River, Wisconsin.
  - 181 Q. Hay Creek, Wisconsin.
  - 181 R. Wolf Fork, Wisconsin.
  - 181 S. East Branch of Eau Claire River, Wisconsin.
- 181 T. Duncan Creek, Wisconsin.
- 181 U. Yellow River, Wisconsin.
- 181 V. Fisher River, Wisconsin.
- 181 W. Jump River, Wisconsin.
  - 181 X. Main Creek, Wisconsin.
  - 181 Y. Jump Creek, Wisconsin.
  - 181 Z. Silver Creek, Wisconsin.
- 181 A2. Deer Tail Creek, Wisconsin.
- 181 B2. Flambeau River, Wisconsin.
  - 181 C2. Manedowish River, Wisconsin.

181. Chippewa River, Wisconsin—Continued.
181 D2. Little Elk River, Wisconsin.
181 E2. Big Elk River, Wisconsin.
181 F2. Pike Lake and River, Wisconsin.
181 G2. Butternut Creek, Wisconsin.
181 H2. Turtle Lake, Wisconsin.
181 J2. Lac de Flambeau, Wisconsin.
181 K2. Soft Maple Creek, Wisconsin.
181 L2. Thorn-Apple River, Wisconsin.
181 M2. Mad Creek, Wisconsin.
181 N2. Burnett River, Wisconsin.
181 O2. Court Oreilles River, Wisconsin.
181 P2. Lakes Oreilles and Grindstone, Wisconsin.
181 Q2. East Branch of Chippewa River, Wisconsin.
181 R2. Crop Lake, Wisconsin.
181 S2. Moose River, Wisconsin.

182. Saint Croix River, Wisconsin.
182 A. Kinnikinnick Creek, Wisconsin.
182 B. Willow River, Wisconsin.
182 C. Apple River, Wisconsin.
182 D. Balsam Branch and Lake, Wisconsin.
182 E. Bone and Round Lakes, Wisconsin.
182 F. Trade River and Lake, Wisconsin.
182 G. Wood River and Lakes, Wisconsin.
182 H. Snake River, Minnesota.
182 J. Kettle River, Minnesota.
182 K. Bear Creek, Minnesota.
182 L. Sand River, Minnesota.
182 M. Tamarack River, Minnesota.
182 N. Clam River and Lake, Wisconsin.
182 O. Yellow Lake and River, and Mud Lake, Wisconsin.
182 P. Namekagon River, Wisconsin.
182 Q. Potogatic, or Tologatick River, Wisconsin.
182 R. Pokegamma Lakes, Wisconsin.
182 S. McKenzie's Lake, Wisconsin.
182 T. Namekagon Lake, Wisconsin.
182 U. Upper Saint Croix Lake, Wisconsin.
182 V. Eau Claire River and Lake, Wisconsin.

183. Minnesota River, Minnesota.
183 A. Gold Lake, Minnesota.
183 B. Perch Lake, Minnesota.
183 C. Blue Earth River, Minnesota.
183 D. Elm River, Minnesota.
183 E. Big Cottonwood River, Minnesota.
183 F. Sleepy Eye Creek, Minnesota.
183 G. Red Wood River, Minnesota.

183. Minnesota River, Minnesota—Continued.
- 183 H. Hawk Creek, Minnesota.
- 183 J. Yellow Medicine River, Minnesota.
- 183 K. Chippewa River, Minnesota.
- 183 L. Lake Johanna and White Bear Lake, Minnesota.
- 183 M. Lac Qui Parle River, Minnesota and Dakota.
- 183 N. Pomme de Terre River, Minnesota.
- 183 O. Pomme de Terre Lake, Minnesota.
- 183 P. Yellow Bank River, Minnesota and Dakota.
- 183 Q. Manka River, Minnesota and Dakota.
- 183 R. Big Stone Lake, Minnesota and Dakota.

184. Bayou Lafourche, Louisiana.
185. Bayou Terrebonne, Louisiana.
186. Petit Bayou, Louisiana.
187. Bayou de Large, Louisiana.
188. Atchafalaya River, Louisiana.
- 188 A. Bayou Teche, Louisiana.

189. Bayou Sale, Louisiana.
190. Vermillion River, Louisiana.
191. Fresh Water Bayou, Louisiana.
192. Mermenton River, Louisiana.
- 192 A. Bayou Lacacene, Louisiana.
- 192 B. Bayou Nezpique, Louisiana.
- 192 C. Bayou Canes, Louisiana.
- 192 D. Bayou Plaquemine, Louisiana.
- 192 E. Bayou Millet, Louisiana.
- 192 F. Bayou Queue de Tortue, Louisiana.
- 192 G. Indian Bayou, Louisiana.

193. Calcasieu River, Louisiana.
- 193 A. West Fork of Calcasieu River, Louisiana.
- 193 B. Indian Bayou, Louisiana.
- 193 C. Little Calcasieu River, Louisiana.
- 193 D. Martin's Creek, Louisiana.
- 193 E. Bundick's Creek, Louisiana.
- 193 F. Bayou Whisky Chitto, Louisiana.
- 193 G. Bayou Comrade, Louisiana.

194. Sabine River, Louisiana and Texas.
- 194 A. Hillsbrand Creek, Texas.
- 194 B. Taylor Bayou, Texas.
- 194 C. Mayhow Bayou, Texas.
- 194 D. Johnson's Bayou, Louisiana.
- 194 E. Willow Bayou, Louisiana.
- 194 F. Nechez River, Texas.
- 194 G. Pine Island Bayou, Texas.
- 194 H. Little Pine Island Bayou, Texas.
- 194 J. Alabama or Village Creek, Texas.

194. Sabine River, Louisiana and Texas—Continued.
194 K. Turkey Creek, Texas.
194 L. Big Sandy Creek, Texas.
194 M. Black Creek, Texas.
194 N. Sandy Creek, Texas.
194 O. Wolf Creek, Texas.
194 P. Angelina River, Texas.
194 Q. Avish Bayou, Texas.
194 R. Tiger Creek, Texas.
194 S. Altoyac Creek, Texas.
194 T. Arenosa Creek, Texas.
194 U. Naconichi Creek, Texas.
194 V. Wandes Creek, Texas.
194 W. Carizzo Creek, Texas.
194 X. Mud Creek, Texas.
194 Y. Shawnee Creek, Texas.
194 Z. Piney Creek, Texas.
194 A2. Alabama Creek, Texas.
194 B2. Walnut Creek, Texas.
194 C2. Alder Bayou, Texas.
194 D2. Cypress Creek, Texas.
194 E2. Flat Creek, Texas.
194 F2. Big Cow Creek, Texas.
194 G2. Lanacoco Bayou, Louisiana.
194 H2. Toreau Bayou, Louisiana.
194 J2. Brookland Sandy Creek, Texas.
194 K2. Housan Creek, Texas.
194 L2. Lennan Bayou, Louisiana.
194 M2. Harpoon Bayou, Louisiana.
194 N2. San Miguel Bayou, Louisiana.
194 O2. Saint Patries Bayou, Louisiana.
194 P2. Big Blue Creek, Texas.
194 Q2. Tancha Creek, Texas.
194 R2. Castor Bayou, Texas.
194 S2. Murvaul Bayou, Texas.
194 T2. Iron Bayou, Texas.
194 U2. Lake Fork of Sabine River, Texas.
194 V2. Cowleach Fork of Sabine River, Texas.
195. Trinity River, Texas.
195 A. Big Bayou, Texas.
195 B. Nelson's Creek, Texas.
195 C. Bedais Creek, Texas.
195 D. South Bedais Creek, Texas.
195 E. Larrison's Creek, Texas.
195 F. Negro Creek, Texas.
195 G. Caney Creek, Texas.

195. Trinity River, Texas—Continued.
195 H. Lost Creek, Texas.
195 J. Hurricane Creek, Texas.
195 K. Box's Creek, Texas.
195 L. Catfish Bayou, Texas.
195 M. Eureka Pecan Creek, Texas.
195 N. Grape Creek, Texas.
195 O. Richland Creek, Texas.
195 P. Chambers Creek, Texas.
195 Q. North Fork of Chambers Creek, Texas.
195 R. Waxahachie Creek, Texas.
195 S. Cedar Creek, Texas.
195 T. Twin Creek, Texas.
195 U. Lacy's Creek, Texas.
195 V. Ferris Fork of Cedar Creek, Texas.
195 W. Cummings Creek, Texas.
195 X. Bois d'Arc Creek, Texas.
195 Y. Pilot Creek, Texas.
195 Z. Wilson's Creek, Texas.
195 A2. Spring Creek, Texas.
195 B2. Grave Creek, Texas.
195 C2. Five-mile Creek, Texas.
195 D2. Denton Fork of Trinity River, Texas.
195 E2. Elizabeth Creek, Texas.
195 F2. Olivers Creek, Texas.
195 G2. Denton Creek, Texas.
195 H2. Pecan Creek, Texas.
195 J2. Isle Au Bois Creek, Texas.
195 K2. Clear Creek, Texas.
195 L2. West Fork of Trinity River, Texas.
195 M2. Caddo Creek, Texas.
195 N2. Fossil Creek, Texas.
195 O2. Cottonwood Creek, Texas.
195 P2. Mary's Creek, Texas.
195 Q2. Ash Creek, Texas.
195 R2. Walnut Creek, Texas.
195 S2. Salt Creek, Texas.
195 T2. Garrett's Creek, Texas.
195 U2. Sandy Creek, Texas.
195 V2. Mitchell's Creek, Texas.
195 W2. Thompson's Creek, Texas.
195 X2. Martin's Creek, Texas.
195 Y2. Bean's Creek, Texas.
195 Z2. Carroll's Creek, Texas.
195 A3. Lost Creek, Texas.
195 B3. Franks Creek, Texas.
195 C3. Brushy Creek, Texas.

196. Brazos River, Texas.
- 196. A. Cow Bayou, Texas.
- 196. B. Fairchilds Creek, Texas.
- 196. C. Big Creek, Texas.
- 196. D. Jones Creek, Texas.
- 196. E. Navasota River, Texas.
- 196. F. Cedar Creek, Texas.
- 196. G. Steels Creek, Texas.
- 196. H. Mustang Creek, Texas.
- 196. J. Buffalo Creek, Texas.
- 196. K. Christiana Creek, Texas.
- 196. L. First Yegua River, Texas.
- 196. M. Davidson's Creek, Texas.
- 196. N. Birch Creek, Texas.
- 196. O. Second Yegua River, Texas.
- 196. P. Cedar Creek, Texas.
- 196. Q. Little Brazos River, Texas.
- 196. R. Little River, Texas.
- 196. S. Pond Creek, Texas.
- 196. T. Mustang Creek, Texas.
- 196. U. Alligator Creek, Texas.
- 196. V. Donahoes Creek, Texas.
- 196. W. Darrs Creek, Texas.
- 196. X. Lampapas Creek, Texas.
- 196. Y. Rocky Creek, Texas.
- 196. Z. Mosquito Creek, Texas.
- 196 A2. Salt Creek, Texas.
- 196 B2. Taylors Creek, Texas.
- 196 C2. Lucus Creek, Texas.
- 196 D2. Fall Creek, Texas.
- 196 E2. School Creek, Texas.
- 196 F2. Sims Creek, Texas.
- 196 G2. Bennet Creek, Texas.
- 196 H2. Cowhouse Creek, Texas.
- 196 J2. House Creek, Texas.
- 196 K2. Table Rock Creek, Texas.
- 196 L2. Beehouse Creek, Texas.
- 196 M2. Leon River, Texas.
- 196 N2. Hensons Creek, Texas.
- 196 O2. Grays Creek, Texas.
- 196 P2. Plum Creek, Texas.
- 196 Q2. Eagle Creek, Texas.
- 196 R2. Warren Creek, Texas.
- 196 S2. South Leon Creek, Texas.
- 196 T2. Rush Creek, Texas.
- 196 U2. Waynes Creek, Texas.

196. Brazos River, Texas—Continued.

196 V2. North Fork of Leon River, Texas.
196 W2. Big Creek, Texas.
196 X2. Walnut Creek, Texas.
196 Y2. Elm Fork of Brazos River, Texas.
196 Z2. Cottonwood Creek, Texas.
196 A3. Bosque River, Texas.
196 B3. South Bosque Creek, Texas.
196 C3. Rainey's Creek, Texas.
196 D3. Hog Creek, Texas.
196 E3. Noels Creek, Texas.
196 F3. Meridian Creek, Texas.
196 G3. Duffau Creek, Texas.
196 H3. Honey Creek, Texas.
196 J3. Gilmore Creek, Texas.
196 K3. Green's Creek, Texas.
196 L3. Alarm Creek, Texas.
196 M3. Cobbs Creek, Texas.
196 N3. Childres Creek, Texas.
196 O3. Daringtons Creek, Texas.
196 P3. Palo Pinto Creek, Texas.
196 Q3. Buck Creek, Texas.
196 R3. Sabine Creek, Texas.
196 S3. Bartons Creek, Texas.
196 T3. Rush Creek, Texas.
196 U3. South Fork of Palo Pinto Creek, Texas.
196 V3. Walnut Creek, Texas.
196 W3. Smith's Creek, Texas.
196 X3. Keochi Creek, Texas.
196 Y3. East Fork of Keochi Creek, Texas.
196 Z3. Salt Creek, Texas.
196 A4. Ioni Creek, Texas.
196 B4. Cedar Creek, Texas.
196 C4. Caddo Creek, Texas.
196 D4. Cedar Bluff Creek, Texas.
196 E4. Clear Fork of Brazos River, Texas.
196 F4. McLanes Creek, Texas.
196 G4. Hubbard's Creek, Texas.
196 H4. Duck Creek, Texas.
196 J4. Sandy Creek, Texas.
196 K4. Fish Creek, Texas.
196 L4. Asylum Creek, Texas.
196 M4. College Creek, Texas.
196 N4. Jennies Creek, Texas.
196 O4. Crane Creek, Texas.
196 P4. Rusts Creek, Texas.

196. Brazos River, Texas—Continued.
196 Q4. Black Creek, Texas.
196 R4. Foyles Creek, Texas.
196 S4. Trout Creek, Texas.
196 T4. Limpid Creek, Texas.
196 U4. Paint Creek, Texas.
196 V4. California Creek, Texas.
196 W4. Oleys Creek, Texas.
196 X4. North Elm Creek, Texas.
196 Y4. South Elm Creek, Texas.
196 Z4. Little Elm Creek, Texas.
196 A5. Buck Creek, Texas.
196 B5. Rainey Creek, Texas.
196 C5. Live Oak Creek, Texas.
196 D5. Red Creek, Texas.
196 E5. Fish Creek, Texas.
196 F5. Elm Creek, Texas.
196 G5. Paint Creek, Texas.
196 H5. Boggy Creek, Texas.
196 J5. Camp Creek, Texas.
196 K5. Lake Creek, Texas.
196 L5. Croton Creek, Texas.
196 M5. Salt Fork of Brazos River, Texas.
196 N5. Double Mountain Fork of Brazos River, Texas.
196 O5. Mulberry Creek, Texas.
196 P5. Salt Creek, Texas.
196 Q5. Duck Creek, Texas.
196 R5. Cat-Fish Creek, Texas.
196 S5. Fresh Water Creek, Texas.
197. San Bernard River, Texas.
198. Linville River, Texas.
199. Colorado River, Texas.
199 A. Blue Creek, Texas.
199 B. Skull Creek, Texas.
199 C. Rabbit Creek, Texas.
199 D. Walnut Creek, Texas.
199 E. Cedar Creek, Texas.
199 F. Piney Creek, Texas.
199 G. Sandy Creek, Texas.
199 H. Cow Creek, Texas.
199 J. Pedernales River, Texas.
199 K. Grape Creek, Texas.
199 L. Palo Alto Creek, Texas.
199 M. Barons Creek, Texas.
199 N. Live Oak Creek, Texas.
199 O. Spring Creek, Texas.

199. Colorado River, Texas—Continued.

199 P. White Oak Creek, Texas.
199 Q. Cypress Creek, Texas.
199 R. Pot Creek, Texas.
199 S. Llano River, Texas.
199 T. Pecan Creek, Texas.
199 U. Johnson Creek, Texas.
199 V. Hickory Creek, Texas.
199 W. Beaver Creek, Texas.
199 X. Rock Creek, Texas.
199 Y. James River, Texas.
199 Z. Honey Creek, Texas.
199 A2. Leon Creek, Texas.
199 B2. Ionia Creek, Texas.
199 C2. Bluff Creek, Texas.
199 D2. Elm Fork of Llano River, Texas.
199 E2. South Fork of Llano River, Texas.
199 F2. Paint Rock Creek, Texas.
199 G2. North Fork of Llano River, Texas.
199 H2. Viejo Creek, Texas.
199 J2. Deer Creek, Texas.
199 K2. Cherokee Creek, Texas.
199 L2. San Saba River, Texas.
199 M2. Richland Creek, Texas.
199 N2. Brady's Creek, Texas.
199 O2. Camp Creek, Texas.
199 P2. Leon Creek, Texas.
199 Q2. Crawfords Creek, Texas.
199 R2. Howard Creek, Texas.
199 S2. Bowies Creek, Texas.
199 T2. Moore Creek, Texas.
199 U2. Pecan Creek, Texas.
199 V2. Brown Creek, Texas.
199 W2. Blanket Creek, Texas.
199 X2. Pecan Bayou, Texas.
199 Y2. Paint Creek, Texas.
199 Z2. Green Creek, Texas.
199 A3. Hood's Creek, Texas.
199 B3. Robertson Creek, Texas.
199 C3. Jim Neds Creek, Texas.
199 D3. Wilborger Creek, Texas.
199 E3. Deer Creek, Texas.
199 F3. Indian Creek, Texas.
199 G3. Clear Creek, Texas,
199 H3. Thetis Creek, Texas.
199 J3. Mukewater Creek, Texas.

199. Colorado River, Texas—Continued.
199 K3. Home Creek, Texas.
199 L3. Victoria Creek, Texas.
199 M3. Eunomia Creek, Texas.
199 N3. Doods Creek, Texas.
199 O3. Urania Creek, Texas.
199 P3. Terpsichore Creek, Texas.
199 Q3. Concho River, Texas.
199 R3. Kickapoo Creek, Texas.
199 S3. Snake Creek, Texas.
199 T3. Edge Creek, Texas.
199 U3. Cottonwood Creek, Texas.
199 V3. Catalah Creek, Texas.
199 W3. Erika Creek, Texas.
199 X3. Tom Jeff's Creek, Texas.
199 Y3. North Concho or Salt Fork of Colorado River, Texas.
199 Z3. Vineyard Creek, Texas.
199 A4. Sterling Creek, Texas.
199 B4. Coffee Creek, Texas.
199 C4. Crystal Creek, Texas.
199 D4. Stampede Creek, Texas.
199 E4. South Concho River, Texas.
199 F4. Antelope Creek, Texas.
199 G4. Burkes Creek, Texas.
199 H4. Good Spring Fork of Concho River, Texas.
199 J4. Dove Creek, Texas.
199 K4. Lepan Creek, Texas.
199 L4. Middle Concho River, Texas.
199 M4. Majors Creek, Texas.
199 N4. Corretts Creek, Texas.
199 O4. Red Fork of Colorado River, Texas.
199 P4. Mulatto Creek, Texas.
199 Q4. Black Creek, Texas.
199 R4. Coyote Creek, Texas.
199 S4. Tule Creek, Texas.
199 T4. Bluff Creek, Texas.
199 U4. Spring Creek, Texas.
199 V4. Valley Creek, Texas.
199 W4. Fish Creek, Texas.
199 X4. Oak Creek, Texas.
199 Y4. Salt Creek, Texas.
199 Z4. Gypsum Creek, Texas.
199 A5. Wolf Creek, Texas.
199 B5. Yellow Creek, Texas.
199 C5. Gasconade Creek, Texas.

199. Colorado River, Texas—Continued.
    199 D5. Ross Creek, Texas.
    199 E5. Corwins Creek, Texas.
    199 F5. Honey Creek, Texas.
    199 G5. Cherry Creek, Texas.
    199 H5. Willies Creek, Texas.
    199 J5. Little Creek, Texas.
    199 K5. Silver Creek, Texas.
200. Trespalacios Creek, Texas.
201. Carancahua Creek, Texas.
202. Lavaca River, Texas.
    202 A. Mustang Creek, Texas.
    202 B. Navidad River, Texas.
    202 C. Sandy Creek, Texas.
    202 D. South Sandy Creek, Texas.
    202 E. North Sandy Creek, Texas.
    202 F. Lower Rocky Creek, Texas.
    202 G. Little Brushy Creek, Texas.
    202 H. Big Brushy Creek, Texas.
    202 J. Rock Creek, Texas.
    202. K. Pantaus Creek, Texas.
203. Arenosa Creek, Texas.
204. Garcitas Creek, Texas.
205. Union Creek, Texas.
206. Guadalupe River, Texas.
    206 A. San Antonio River, Texas.
    206 B. Manahuilla Creek, Texas.
    206 C. Cabeza Creek, Texas.
    206 D. Hards Creek, Texas.
    206 E. Escondido Creek, Texas.
    206 F. Ecleto Creek, Texas.
    206 G. Toncahua Creek, Texas.
    206 H. Cibolo Creek, Texas.
    206 J. Elm Creek, Texas.
    206 K. Martinez Creek, Texas.
    206 L. Saint Clara Creek, Texas.
    206 M. Balcones Creek, Texas.
    206 N. Marcelinas Creek, Texas.
    206 O. Medina River, Texas.
    206 P. Leon Creek, Texas.
    206 Q. Cottonwood Creek, Texas.
    206 R. Medio Creek, Texas.
    206 S. Cay Creek, Texas.
    206 T. Coleto River, Texas.
    206 U. Perdido Creek, Texas.
    206 V. Eighteen-mile Creek, Texas.

206. Guadalupe River, Texas—Continued.
- 206 W. Sandes Creek, Texas.
  - 206 X. Birds Creek, Texas.
  - 206 Y. Five-mile Creek, Texas.
  - 206 Z. Elm Fork of Sandy Creek, Texas.
  - 206 A2. Salt Fork of Sandy Creek, Texas.
  - 206 B2. Clear Creek, Texas.
- 206 C2. Peach Creek, Texas.
  - 206 D2. South Fork of Peach Creek, Texas.
- 206 E2. Saint Marcos River, Texas.
  - 206 F2. Grass Creek, Texas.
  - 206 G2. Clear Fork of Saint Marcos River, Texas.
  - 206 H2. Plum Creek, Texas.
  - 206 J2. Blanco River, Texas.
- 206 K2. Nash's Creek, Texas.
- 206 L2. Alligator Creek, Texas.
- 206 M2. Canal Creek, Texas.
- 206 N2. Bear Creek, Texas.
- 206 O2. Curry's Creek, Texas.
- 206 P2. Sisters Creek, Texas.
- 206 Q2. Verde Creek, Texas.
- 206 R2. Minters Creek, Texas.
- 206 S2. Guadalupe Creek, Texas.

207. Capano Creek, Texas.

208. Mission River, Texas.
- 208 A. Melon Creek, Texas.
- 208 B. Willow Creek, Texas.
- 208 C. Blanco Creek, Texas.
  - 208 D. Sarco Creek, Texas.
  - 208 E. Millers Creek, Texas.
- 208 F. Medio Creek, Texas.
  - 208 G. San Domingo Creek, Texas.
  - 208 H. Taro Creek, Texas.

209. Aransas River, Texas.
- 209 A. Chiltipin Creek, Texas.
- 209 B. Papalote Creek, Texas.
- 209 C. West Arancas Creek, Texas.
  - 209 D. Bee Creek, Texas.
- 209 E. Talpacute Creek, Texas.
- 209 F. Paesta Creek, Texas.

210. Nueces River, Texas.
- 210 A. Panitas Creek, Texas.
- 210 B. Carcase Creek, Texas.
- 210 C. Paesta Creek, Texas.
- 210 D. Spring Creek, Texas.
- 210 E. Puenta de Piendra Creek, Texas.

210. Nueces River, Texas—Continued.
- 210 F. Frio River, Texas.
- 210 G. Atascosa River, Texas.
- 210 H. South Christoval Creek, Texas.
- 210 J. Turkey Creek, Texas.
- 210 K. Salt Creek, Texas.
- 210 L. Mulato Creek, Texas.
- 210 M. Lepan Creek, Texas.
- 210 N. Lucas Creek, Texas.
- 210 O. Borego Creek, Texas.
- 210 P. Seateadero Creek, Texas.
- 210 Q. San Miguel Creek, Texas.
- 210 R. Clear or Laguna Creek, Texas.
- 210 S. Black Jasper Flores Creek, Texas.
- 210 T. Francisco Perez Creek, Texas.
- 210 U. Chacan Creek, Texas.
- 210 V. Dog Creek, Texas.
- 210 W. Leoncita Creek, Texas.
- 210 X. Esperanea Creek, Texas.
- 210 Y. Canada de Ruiz Creek, Texas.
- 210 Z. Leona River, Texas.
- 210 A2. Todos Santos Creek, Texas.
- 210 B2. Live Oak Creek, Texas.
- 210 C2. Deer Creek, Texas.
- 210 D2. Seco Creek, Texas.
- 210 E2. Tawacano Creek, Texas.
- 210 F2. Hondo Creek, Texas.
- 210 G2. Williams Creek, Texas.
- 210 H2. Thomas Creek, Texas.
- 210 J2. Verde Creek, Texas.
- 210 K2. Sabinal Creek, Texas.
- 210 L2. Blanchero Creek, Texas.
- 210 M2. Turkey Creek, Texas.
- 210 N2. Canon Creek, Texas.
- 210 O2. Kendalls Creek, Texas.
- 210 P2. Blanco Creek, Texas.
- 210 Q2. Olamos Creek, Texas.
- 210 R2. Prieto Creek, Texas.
- 210 S2. La Parida Creek, Texas.
- 210 T2. Salado Creek, Texas.
- 210 U2. Alamito Creek, Texas.
- 210 V2. Tecolete Creek, Texas.
- 210 W2. Las Raices Creek, Texas.
- 210 X2. San Rogue Creek, Texas.
- 210 Y2. Turkey Creek, Texas.
- 210 Z2. West Fork of Nueces River, Texas.
- 210 A3. Gillespies Creek, Texas.

211. Pintos Creek, Texas.
    211 A. Chillipin Creek, Texas.
212. San Fernando Creek, Texas.
    212 A. Tranguitas Creek, Texas.
    212 B. San Diego Creek, Texas.
    212 C. Taranchuas Creek, Texas.
213. Santa Gertrudis Creek, Texas.
    213 A. Escondido Creek, Texas.
    213 B. Anacuas Creek, Texas.
    213 C. Narciseno Creek, Texas.
214. Rio Los Olmos, Texas.
    214 A. Conception Creek, Texas.
    214 B. Agua Poquito Creek, Texas.
215. Santa River, Texas.
    215 A. Antonio Creek, Texas.
    215 B. Cibolo Creek, Texas.
216. Rio Las Animas, Texas.
217. Rio Sal Colorado, Texas.
218. Rio Grande, Texas, New Mexico, and Colorado.
    218 A. Sauz or Olmos River, Texas.
    218 B. Juanito Creek, Texas.
    218 C. Saos Creek, Texas.
    218 D. El Pan Creek, Texas.
    218 E. Santa Jesabel Creek, Texas.
    218 F. Tejones Creek, Texas.
    218 G. Ambrosia Creek, Texas.
    218 H. Cuero Creek, Texas.
    218 J. Cuevas Creek, Texas.
    218 K. Elm or Saus Creek, Texas.
    218 L. Las Moras Creek, Texas.
    218 M. Zoquete Creek, Texas.
    218 N. Sycamore Creek, Texas.
    218 O. Marerick's Creek, Texas.
    218 P. San Felipe Creek, Texas.
    218 Q. Pedro Creek, Texas.
    218 R. Devils River, Texas.
    218 S. Ricardo Creek, Texas.
    218 T. Pecos River, Texas.
    218 U. Howard Creek, Texas.
    218 V. Live Oak Creek, Texas.
    218 W. Teyeh Creek, Texas.
    218 X. Delaware Creek, Texas and New Mexico.
    218 Y. Blue River, New Mexico.
    218 Z. Black River, Texas and New Mexico.
    218 A2. Rio Azul or Sacramento, New Mexico.
    218 B2. Seven Rivers, New Mexico.

218. Rio Grande, Texas, New Mexico, and Colorado—Continued.

218 C2. Rio Penasco, New Mexico.
218 D2. Arrojo Creek, New Mexico.
218 E2. Cottonwood Creek, New Mexico.
218 F2. Rio Felix, New Mexico.
218 G2. Rio Hondo or Bonito, New Mexico.
218 H2. Alacas River, New Mexico.
218 J2. Ruidosa River, New Mexico.
218 K2. Eagle Creek, New Mexico.
218 L2. Rio del Toro, New Mexico.
218 M2. Canada de Yeso Creek, New Mexico.
218 N2. Arroyo Salado, New Mexico.
218 O2. Arroyo Alamo Gordo, New Mexico.
218 P2. Arroyo Portrillo, New Mexico.
218 Q2. San Juan de Diaz Creek, New Mexico.
218 R2. Agua Negra Chicita Creek, New Mexico.
218 S2. Rio Gallinas, New Mexico.
218 T2. Rio de la Vaco, New Mexico.
218 U2. Painted Rock Creek, Texas.
218 V2. San Francisco River, Texas.
218 W2. Rio de las Animas, New Mexico.
218 X2. Rio Frio, New Mexico.
218 Y2. Rio Palomas, New Mexico.
218 Z2. Arroyo de la Cuchilla Negro, New Mexico.
218 A3. Canada Alamosa River, New Mexico.
218 B3. Pinon Creek, New Mexico.
218 C3. Alamilla Arroyo, New Mexico.
218 D3. Rio Puerco, New Mexico.
218 E3. Rio San José, New Mexico.
218 F3. Arroyo Placita, New Mexico.
218 G3. Cebolleta Creek, New Mexico.
218 H3. Canada de la Cuerre Creek, New Mexico.
218 J3. Arroyo San Miguel, New Mexico.
218 K3. Jemez River, New Mexico.
218 L3. Guadalupe Creek, New Mexico.
218 M3. East Fork of Jemez River, Mew Mexico.
218 N3. San Antonio Creek, New Mexico.
218 O3. Santa Fé Creek, New Mexico.
218 P3. Rio Hondo, New Mexico.
218 Q3. Rio Frijoles, New Mexico.
218 R3. Rio Chama, New Mexico.
218 S3. Caliente Creek, New Mexico.
218 T3. Oso Creek, New Mexico.
218 U3. El Rito Creek, New Mexico.
218 V3. Cangillon Creek, New Mexico.
218 W3. Salinas Creek, New Mexico.

218. Rio Grande, Texas, New Mexico, and Colorado—Continued.

218 X3. Gallinas Creek, New Mexico.
218 Y3. Capulin Creek, New Mexico.
218 Z3. Cebello River, New Mexico.
218 A4. Nutrias Creek, New Mexico.
218 B4. Nutritas Creek, New Mexico.
218 C4. Taos Creek, New Mexico.
218 D4. Red River, New Mexico.
218 E4. Rio Costillo, New Mexico.
218 F4. San Antonio River, New Mexico and Colorado.
218 G4. Rio Conejos, Colorado.
218 H4. Los Pinos Creek, New Mexico and Colorado.
218 J4. San Antonio Creek, New Mexico and Colorado.
218 K4. La Jara Creek, Colorado.
218 L4. Alamosa Creek, Colorado.
218 M4. Embargo Creek, Colorado.
218 N4. South Fork of Rio Grande, Colorado.
218 O4. Hot Creek, Colorado.
218 P4. Trout Creek, Colorado.
218 Q4. Willow Creek, Colorado.
218 R4. Champagne Creek, Colorado.
218 S4. Crooked Creek, Colorado.
218 T4. Hines Fork of Rio Grande, Colorado.

219. Gulf of California, Mexico.

219 A. Colorado River, Arizona, California, Nevada, and Utah.
219 B. GILA RIVER, Arizona and New Mexico, *vide* 220.
219 C. Dry Creek, California.
219 D. Carroll's Creek, California.
219 E. Laguna Lake, California.
219 F. BILL WILLIAMS FORK OF COLORADO RIVER, Arizona, *vide* 222.
219 G. Pah-ute Creek, California.
219 H. Sacramento Wash, Arizona.
219 J. Virgin River, Nevada, Arizona, and Utah.
219 K. Muddy River, Nevada.
219 L. Beaver Dam Wash, Arizona and Utah.
219 M. Santa Clara River, Utah.
219 N. Ash Creek, Utah.
219 O. Harmony River, Utah.
219 P. Le Verkin Creek, Utah.
219 Q. Taylors Creek, Utah.
219 R. Grand Wash, Arizona.
219 S. Cataract Creek, Arizona.
219 T. CedarCreek, Arizona.
219 U. Park Creek, Arizona.

219. Gulf of California, Mexico—Continued.

219 V. Kanab Wash, Arizona and Utah.
219 W. LITTLE COLORADO RIVER, Arizona, *vide* 223.
219 X. Soap Creek, Arizona.
219 Y. Badger Creek, Arizona.
219 Z. Pahreah River, Arizona and Utah.
219 A2. Cottonwood Creek, Utah.
219 B2. Lake Adair, Utah.
219 C2. Warm Creek, Arizona and Utah.
219 D2. SAN JUAN RIVER, Utah, New Mexico, *vide* 224.
219 E2. Escalantes River, Utah.
219 F2. Boulder Creek, Utah.
219 G2. False Creek, Utah.
219 H2. Pine Creek, Utah.
219 J2. Mamiss Creek, Utah.
219 K2. Windsor Creek, Utah.
219 L2. Birch Creek, Utah.
219 M2. Alcove Creek, Utah.
219 N2. Trachype Creek, Utah.
219 O2. Curtis Creek, Utah.
219 P2. Dirty Devil River, Utah.
219 Q2. Tantalus Creek, Utah.
219 R2. Temple Creek, Utah.
219 S2. Fremont River, Utah.
219 T2. Little Creek, Utah.
219 U2. Starvation Creek, Utah.
219 V2. Saleratus Creek, Utah.
219 W2. Ivie Creek, Utah.
219 X2. Queat-Chup-Pa Creek, Utah.
219 Y2. Muddy Creek, Utah.
219 Z2. GRAND RIVER, Utah and Colorado, *vide* 225.
219 A3. GREEN RIVER, Utah, Colorado, and Wyoming, *vide* 226.

220. Gila River, Arizona and New Mexico.

220 A. Hassayampa Creek, Arizona.
220 B. Aqua Fria River, Arizona.
220 C. Cave Creek, Arizona.
220 D. Humbug Creek, Arizona.
220 E. Stale Creek, Arizona.
220 F. Lynn Creek, Arizona.
220 G. Salt River, Arizona, *vide* 221.
220 H. Mineral Creek, Arizona.
220 J. San Pedro River, Arizona.
220 K. Rio Arivaypa, Arizona.
220 L. Petahava Creek, Arizona.

220. Gila River, Arizona and New Mexico—Continued.
220 M. Prospect Creek, Arizona.
220 N. Saddle Creek, Arizona.
220 O. Deer Creek, Arizona.
220 P. Rock Creek, Arizona.
220 Q. San Carlos River, Arizona.
220 R. Aliso Creek, Arizona.
220 S. Sycamore Creek, Arizona.
220 T. Ash Creek, Arizona.
220 U. Mescal Creek, Arizona.
220 V. Rio San Domingo or Rio de Sauz, Arizona.
220 W. Rio Bonito, Arizona.
220 X. Eagle Creek, Arizona.
220 Y. San Francisco River, Arizona and New Mexico.
220 Z. Rio Blanco, New Mexico.
220 A2. Rio Cabezon, New Mexico.
220 B2. Rio Aliso, New Mexico.
220 C2. Rio Talerosa, New Mexico.
220 D2. Rio Perdito, New Mexico.
220 E2. Burnt Fork of Rio Talerosa, New Mexico.
220 F2. Duck Creek, New Mexico.
220 G2. Bear Creek, New Mexico.
220 H2. Rio Palo, New Mexico.
221. Salt River, Arizona.
221 A. Rio Verde, Arizona.
221 B. Sycamore Creek, Arizona.
221 C. Camp Creek, Arizona.
221 D. Rice Creek, Arizona.
221 E. Graham Creek, Arizona.
221 F. Bog Creek, Arizona.
221 G. Red Creek, Arizona.
221 H. Crove Creek, Arizona.
221 J. Oak Creek, Arizona.
221 K. East Fork of Rio Verde, Arizona.
221 L. Krauss Creek, Arizona.
221 M. Rock Creek, Arizona.
221 N. Pine Creek, Arizona.
221 O. Ash Creek, Arizona.
221 P. Hardscrabble Creek, Arizona.
221 Q. Fossil Creek, Arizona.
221 R. Clear Creek, Arizona.
221 S. Main Beaver Creek, Arizona.
221 T. Dragoon Creek, Arizona.
221 U. Granite Creek, Arizona.
221 V. Partridge Creek, Arizona.
221 W. Cañon Creek, Arizona.

221. Salt River, Arizona—Continued.
- 221 X. Castle Creek, Arizona.
- 221 Y. Pine Creek, Arizona.
- 221 Z. Skull Creek, Arizona.
- 221 A2. Black River, Arizona.
  - 221 B2. Island Creek, Arizona.
  - 221 C2. Pinto Creek, Arizona.
  - 221 D2. Pinal Creek, Arizona.
  - 221 E2. Cherry Creek, Arizona.
  - 221 F2. Cañon Creek, Arizona.
    - 221 G2. Locust Creek, Arizona.
      - 221 H2. Oak Creek, Arizona.
  - 221 J2. Coon Creek, Arizona.
  - 221 K2. Sibicu Creek, Arizona.
    - 221 L2. Butler Creek, Arizona.
  - 221 M2. Carrizo Creek, Arizona.
    - 221 N2. Cedar Creek, Arizona.
  - 221 O2. White Mountain River, Arizona.
  - 221 P2. Milpha Creek, Arizona.
  - 221 Q2. Neutroso Creek, Arizona.
- 221 R2. Greenback Creek, Arizona.
- 221 S2. Tonto Creek, Arizona.
- 221 T2. Deer Creek, Arizona.
- 221 U2. Oak Creek, Arizona.

222. Bill Williams Fork of Colorado River, Arizona.
- 222 A. Santa Maria River, Arizona.
  - 222 B. Date Creek, Arizona.
  - 222 C. Kirkland Creek, Arizona.
  - 222 D. Sycamore Creek, Arizona.
- 222 E. Burro Creek, Arizona.
  - 222 F. San Francisco Creek, Arizona.
  - 222 G. Spencer Creek, Arizona.
  - 222 H. Boulder Creek, Arizona.
  - 222 J. Rock Creek, Arizona.
- 222 K. Wake Up Wash, Arizona.
- 222 L. Big Sandy Creek, Arizona.
  - 222 M. Deluge Wash, Arizona.
  - 222 N. Trout Creek, Arizona.
  - 222 O. Grapevine Creek, Arizona.
  - 222 P. Cliff Creek, Arizona.

223. Little Colorado River, Arizona.
- 223 A. Dry Wash, Arizona.
- 223 B. Dry Wash, Arizona.
- 223 C. Cottonwood Creek, Arizona.
  - 223 D. Colorado Creek, Arizona.
- 223 E. Rio Puerco, Arizona and New Mexico.

223. Little Colorado River, Arizona—Continued.
    223 F. Lithodondron Creek, Arizona.
    223 G. Carrizo Creek, Arizona.
    223 H. Bonito Creek, Arizona.
    223 J. Silver Creek, Arizona.
    223 K. Showlow Creek, Arizona.
    223 L. Zuni River, Arizona and New Mexico.
224. San Juan River, Utah, New Mexico, and Colorado.
    224 A. Epson Creek, Utah.
    224 B. Rio de Chelly, Utah and Arizona.
    224 *Ba*. Dry Creek, Arizona.
    224 C. Rio Carizo, Utah and Arizona.
    224 D. Hallett's Creek, Utah.
    224 E. Recapture Creek, Utah.
    224 F. Montezuma Creek, Utah and Colorado.
    224 G. McElmo Creek, Utah and Colorado.
    224 H. Rio Manco, Colorado.
    224 J. Rio de Chaco, New Mexico.
    224 K. Rio del Pajarito, New Mexico.
    224 L. Tunicha Creek, New Mexico.
    224 M. Vaca River, New Mexico.
    224 N. Rio La Plata, New Mexico and Colorado.
    224 O. Rio de las Animas, New Mexico and Colorado.
    224 P. Hermosa Creek, Colorado.
    224 Q. Rio de los Pinos, New Mexico and Colorado.
    224 R. Rio Piedra, Colorado.
    224 S. Rio Navajo, Colorado.
225. Grand River, Utah and Colorado.
    225 A. Deep Creek, Utah.
    225 B. Mill Creek, Utah.
    225 C. Little Castle Creek, Utah.
    225 D. Dolores River, Utah and Colorado.
    225 E. West Creek, Colorado.
    225 F. Rio la Sal, Utah and Colorado.
    225 G. Rio San Miguel, Colorado.
    225 H. Tabegache Creek, Colorado.
    225 J. Naturita Creek, Colorado.
    225 K. Juhuhnikavatz Creek, Utah and Colorado.
    225 L. Disappointment Creek, Colorado.
    225 M. Plateau Creek, Colorado.
    225 N. Little Cañon Creek, Colorado.
    225 O. Desert Creek, Utah.
    225 P. Rio Dolores Chiquito, Utah and Colorado.
    225 Q. Bitter Waters Creek, Utah.
    225 R. West Salt Creek, Colorado.
    225 S. East Salt Creek, Colorado.

225. Grand River, Utah and Colorado—Continued.
225 T. Gunnison River, Colorado.
225 U. Whitewater Creek, Colorado.
225 V. East Creek, Colorado.
225 W. Kahnah Creek, Colorado.
225 X. Rio Dominquez Creek, Colorado.
225 Y. Rio Escalante Creek, Colorado.
225 Z. Roubideau's Creek, Colorado.
225 A2. Uncompahgre River, Colorado.
225 B2. Cedar Creek, Colorado.
225 C2. Forked Tongued Creek, Colorado.
225 D2. Surface Creek, Colorado.
225 E2. Cimaron Creek, Colorado.
225 F2. Cebolla Creek, Colorado.
225 G2. Blue Creek, Colorado.
225 H2. Mountain Creek, Colorado.
225 J2. White Earth Creek, Colorado.
225 K2. Beaver Creek, Colorado.
225 L2. Cochetopa Creek, Colorado.
225 M2. Cottonwood Creek, Colorado.
225 N2. Quartz Creek, Colorado.
225 O2. Hot Spring Creek, Colorado.
225 P2. Tomichi Creek, Colorado.
225 Q2. Ohio Creek, Colorado.
225 R2. Stale River, Colorado.
225 S2. Cascade Creek, Colorado.
225 T2. Cloud Creek, Colorado.
225 U2. Taylors Creek, Colorado.
225 V2. Plateau Creek, Colorado.
225 W2. Roan Creek, Colorado.
225 X2. Rifle Creek, Colorado.
225 Y2. Mam Creek, Colorado.
225 Z2. Divide Creek, Colorado.
225 A3. Elk Creek, Colorado.
225 B3. Roaring Fork of Grand River, Colorado.
225 C3. Rock Creek, Colorado.
225 D3. Sopris Creek, Colorado.
225 E3. South Sopris Creek, Colorado.
225 F3. Frying Pan Creek, Colorado.
225 G3. Woody Creek, Colorado.
225 H3. Maroon Creek, Colorado.
225 J3. Hunters Creek, Colorado.
225 K3. Castle Creek, Colorado.
225 L3. Difficult Creek, Colorado.
225 M3. Eagle River, Colorado.
225 N3. Gypsum Creek, Colorado.

225. Grand River, Utah and Colorado—Continued.
225 O3. Brush Creek, Colorado.
225 P3. Gores Creek, Colorado.
225 Q3. Roche Montannee Creek, Colorado.
225 R3. Homestake Creek, Colorado.
225 S3. Rock Creek, Colorado.
225 T3. Egeria Creek, Colorado.
225 U3. Piney River, Colorado.
225 V3. Stampede Creek, Colorado.
225 W3. Blue River, Colorado.
225 X3. Muddy Creek, Colorado.
225 Y3. Williams River, Colorado.
225 Z3. Fraser River, Colorado.
225 A4. Pole Creek, Colorado.
225 B4. Crooked Creek, Colorado.
225 C4. Saint Day Creek, Colorado.
225 D4. Willow Creek, Colorado.
225 E4. Grand Lake, Colorado.
226. Green River, Utah, Colorado, and Wyoming.
226 A. San Rafael River, Utah.
226 B. Shangint Creek, Utah.
226 C. Cottonwood Creek, Utah.
226 D. Huntington Creek, Utah.
226 E. Price River, Utah.
226 F. North Fork of Price River, Utah.
226 G. West Creek, Utah.
226 H. Beaver Dam Creek, Utah.
226 J. West Fork of North Fork of Price River, Utah.
226 K. Pleasant Creek, Utah.
226 L. Standard Creek, Utah.
226 M. White River, Utah.
226 N. Chandler Creek, Utah.
226 O. Melvin's Creek, Utah.
226 P. Minnie Maud Creek, Utah.
226 Q. Bartholemew Creek, Utah.
226 R. Nine-mile Creek, Utah.
226 S. Lost Creek, Utah.
226 T. White River, Utah and Colorado.
226 U. Red Bluff Wash, Utah and Colorado.
226 V. Two Water Creek, Utah.
226 W. Ashpalt Wash, Utah.
226 X. Evacaution Creek, Utah and Colorado.
226 Y. Fox Creek, Colorado.
226 Z. Douglas Creek, Colorado.
226 A2. Weary Mule Creek, Colorado.

226. Green River, Utah, Colorado, and Wyoming—Continued.

226 B2. Guaderonnes Creek, Colorado.
226 C2. Deep Channel Creek, Colorado.
226 D2. Crooked Wash, Colorado.
226 E2. Pi-ce-ance Creek, Colorado.
226 F2. Andros Creek, Colorado.
226 G2. Beaver Creek, Colorado.
226 H2. Faun Creek, Colorado.
226 J2. Marvines Creek, Colorado.
226 K2. Trappers Creek, Colorado.
226 L2. Du Chesne River, Utah.
226 M2. Uintah River, Utah.
226 N2. Dry Gulch Creek, Utah.
226 O2. Deep Creek, Utah.
226 P2. Current Creek, Utah.
226 Q2. Strawberry Creek, Utah.
226 R2. Bad Land Creek, Utah,
226 S2. Cliff Creek, Utah.
226 T2. Brush Creek, Utah.
226 U2. Cub Creek, Utah.
226 V2. Yampah River, Colorado.
226 W2. Pool Creek, Colorado.
226 X2. Signal Shot Creek, Colorado.
226 Y2. Little Snake River, Colorado and Wyoming.
226 Z2. Four-mile Creek, Colorado.
226 A3. White Bull Creek, Colorado.
226 B3. Deception Creek, Colorado.
226 C3. Good Spring Creek, Colorado.
226 D3. Williams River, Colorado.
226 E3. Elk Creek, Colorado.
226 F3. Waddel Creek, Colorado.
226 G3. Fortification Creek, Colorado.
226 H3. Little Beaver Creek, Colorado.
226 J3. Elk Head Creek, Colorado.
226 K3. Sage Creek, Colorado.
226 L3. Elk Creek, Colorado.
226 M3. Harrison Creek, Colorado.
226 N3. Sarvis Creek, Colorado.
226 O3. Pot Creek, Utah and Colorado.
226 P3. Vermillion Creek, Colorado.
226 Q3. Muddy Creek, Colorado.
226 R3. Talamantes Creek, Colorado.
226 S3. Beaver Creek, Colorado.
226 T3. Summit Creek, Utah.
226 U3. Willow Creek, Utah and Wyoming.
226 V3. Kettle Creek, Utah.

226. Green River, Utah, Colorado, and Wyoming—Continued.
    226 W3. Sheep Creek, Utah.
    226 X3. Henry's Fork of Green River, Utah and Wyoming.
    226 Y3. Byrnes Creek, Utah and Wyoming.
    226 Z3. Meyer Creek, Utah and Wyoming.
    226 A4. Beaver Creek, Utah and Wyoming.
    226 B4. Spring Creek, Utah and Wyoming.
    226 C4. Jewett River, Wyoming.
    226 D4. Current Creek, Wyoming.
    226 E4. Muddy Creek, Wyoming.
    226 F4. Sage Creek, Wyoming.
    226 G4. Big Sandy Creek, Wyoming.
    226 H4. Little Sandy Creek, Wyoming.
    226 J4. State Creek, Wyoming.
    226 K5. Fontenelle Creek, Wyoming.
    226 L4. La Barge Creek, Wyoming.
    226 M4. Piney Creek, Wyoming.
    226 N4. Bitter Root Creek, Wyoming.
    226 O4. Marsh Creek, Wyoming.
    226 P4. Horse Creek, Wyoming.
    226 Q4. Lead Creek, Wyoming.
227. Tia Juana River, California.
228. Jamacho River, California.
    228 A. Sweet Water Creek, California.
229. San Diego River, California.
230. Penasquitos Creek, California.
231. Sandiequito River, California.
232. San Luis Rey River, California.
233. Rio San Margarita, California.
    233 A. Temecula River, California.
    233 B. Dry Creek, California.
234. Los Flores Creek, California.
235. San Omofre Creek, California.
236. De San Mateo Creek, California.
237. Alisos Creek, California.
238. Arroyo de Santayo, California.
239. Santa Ana River, California.
240. Temescal Creek, California.
241. Caytoes River, California.
242. San José Creek, California.
243. San Gabriel River, California.
    243 A. Arroyo Seco, California.
    243 B. San José Creek, California.
244. Los Angeles River, California.
245. Cienega River, California.
246. Las Toses River, California.

247. Santa Clara River, California.
 247 A. Mupa Creek, California.
 247 B. Sespe River, California.
 247 C. Pipo River, California.
 247 D. San Francisco Creek, California.
 247 E. Soledad Creek, California.
248. San Buenaventura River, California.
 248 A. Antonia Creek, California.
 248 B. Mataliju Creek, California.
249. Ricon Creek, California.
250. Arroyo Jalame, California.
251. Ynez River, California.
252. San Antonio River, California.
253. Santa Maria, or Cuyama River, California.
 253 A. Sisquoc River, California.
 253 B. Alvios Creek, California.
 253 C. Buasna Creek, California.
254. Arroyo Grande, California.
255. Arroyo del Choveo, California.
256. Moro Creek, California.
257. Old Creek, California.
258. Santa Rosa Creek, California.
259. San Simeon Creek, California.
260. Arroyo del Final, California.
261. Viceno Creek, California.
262. Mill Creek, California.
263. Sun River, California.
264. Arroyo de San Jose, California.
265. Carmel River, California.
 265 A. San Clements Creek, California.
266. Salinas River, California.
 266 A. Chalone Creek, California.
 266 B. San Lorenzo Creek, California.
 266 C. Lewis Creek, California.
 266 D. Dry Creek, California.
 266 E. Gaviola Creek, California.
 266 F. Dry Creek, California.
 266 G. Dry Creek, California.
 266 H. San Antonia River, California.
 266 J. Salina River, California.
 266 K. Buero Huero Creek, California.
 266 L. San Luis Obispo Creek, California.
 266 M. San Jacinto Creek, California.
 266 N. Ranchata Cañon Creek, California.
 266 O. Hogmalley Creek, California.
 266 P. Ceyes Cañon Creek, California.

266. Salinas River, California—Continued.
- 266 Q. Dry Creek, California.
- 266 R. Dry Creek, California.
- 266 S. San Juan Creek, California.
- 266 T. Dry Creek, California.

267. San Benito River, California.
- 267 A. Arroyo de Las Llagas, California.
- 267 B. Arroyo del Bosdrio, California.
- 267 C. Arroyo Joaquin Soto, California.
- 267 D. Big Panoche Creek, California.

268. Arroyo del Rodeo, California.

269. Gurzas Creek, California.

270. Pescadero Creek, California.

271. Bay of San Francisco, California.
- 271 A. Arroyo Capertao, California.
- 271 B. Coyote Creek, California.
- 271 C. Isabel Creek, California.
- 271 D. Calaveras Creek, California.
- 271 E. Arroyo Pleasanton, California.
- 271 F. Arroyo Valley, California.
- 271 G. Arroyo Mocho, California.
- 271 H. Marsh's Creek, California.
- 271 J. Arroyo Cares, California.
- 271 K. Hollow Corral Creek, California.
- 271 L. San Pablo Creek, California.
- 271 M. SACRAMENTO RIVER, California, *vide* 272.
- 271 N. Mill Creek, California.
- 271 O. Puta Creek, California.
- 271 P. Napa River, California.
- 271 Q. Curvieros Creek, California.
- 271 R. Mill Creek, California.
- 271 S. Couns Creek, California.
- 271 T. Sonoma Creek, California.
- 271 U. Colabasas Creek, California.
- 271 V. Arroyo San Antonio, California.

272. Sacramento River, California.
- 272 A. SAN JOAQUIN RIVER, California, *vide* 273.
- 272 B. Rio Vista, California.
- 272 C. Cache Creek, California.
- 272 D. Alamo Creek, California.
- 272 E. American River, California.
- 272 F. Weaver Creek, California.
- 272 G. Brush Creek, California.
- 272 H. Silver Creek, California.
- 272 J. South Fork of American River, California.
- 272 K. Plum Creek, California.

272. Sacramento River, California—Continued.

272 L. Alder Creek, California.
272 M. Silver Fork of American River, California.
272 N. Middle Fork of American River, California.
272 O. Eldorado Creek, California.
272 P. Long Creek, California.
272 Q. North Fork of American River, California.
272 R. Feather River, California.
272 S. Coon Creek, California.
272 T. Bear River, California.
272 U. South Wolf Creek, California.
272 V. Big Dry Creek, California.
272 W. Yuba River, California.
272 X. South Yuba River, California.
272 Y. Cañon Creek, California.
272 Z. North Fork of Yuba River, California.
272 A2. Kanaka Creek, California.
272 B2. Honcut River, California.
272 C2. Wyandotte Creek, California.
272 D2. North Honcut Creek, California.
272 E2. Middle Fork of Feather River, California.
272 F2. Cold Water Creek, California.
272 G2. Willow Creek, California.
272 H2. Berry Creek, California.
272 J2. French Creek, California.
272 K2. Brush Creek California.
272 L2. Marble Creek, California.
272 M2. North Fork of Feather River, California.
272 N2. Grizzly Creek, California.
272 O2. Lime Creek, California.
272 P2. Bucks Creek, California.
272 Q2. Yellow Creek, California.
272 R2. Big Meadow Creek, California.
272 S2. Warners Creek, California.
272 T2. Rice's Creek, California.
272 U2. Grizzly Creek, California.
272 V2. Clover Creek, California.
272 W2. Indian Creek, California.
272 X2. Last Chance Creek, California.
272 Y2. Capay Cache Creek, California.
272 Z2. Cottonwood Creek, California.
272 A3. Bear Creek, California.
272 B3. Cortero Creek, California.
272 C3. Sycamore Slough, California.
272 D3. Big Butte Creek, California.

272. Sacramento River, California—Continued.

272 E3. Dry Creek, California.
272 F3. Table Mountain Creek, California.
272 G3. Little Butte Creek, California.
272 H3. Stony Creek, California.
272 J3. Elk Creek, California.
272 K3. Little Stony Creek, California.
272 L3. Chico Creek, California.
272 M3. Little Chico Creek, California.
272 N3. Mud Creek, California.
272 O3. Rock Creek, California.
272 P3. Moons River, California.
272 Q3. Deer Creek, California.
272 R3. Mill Creek, California.
272 S3. Elder Creek, California.
272 T3. Coyote Creek, California.
272 U3. Cat Creek, California.
272 V3. Dye's Creek, California.
272 W3. Antelope Creek, California.
272 X3. Big Salt Creek, California.
272 Y3. Red Branch Creek, California.
272 Z3. Reed Creek, California.
272 A4. Dibble Creek, California.
272 B4. Battle Creek, California.
272 C4. Digger Creek, California.
272 D4. Bailey Creek, California.
272 E4. Cottonwood Creek, California.
272 F4. Hooker Creek, California.
272 G4. Dry Creek, California.
272 H4. Jerusalem Creek, California.
272 J4. Roaring River, California.
272 K4. Bear Creek, California.
272 L4. Ash Creek, California.
272 M4. Cow Creek, California.
272 N4. Oak Run, California.
272 O4. Clever Creek, California.
272 P4. Little Cow Creek, California.
272 Q4. Cedar Creek, California.
272 R4. Stillwater Creek, California.
272 S4. Churn Creek, California.
272 T4. Motion Creek, California.
272 U4. Square Creek, California.
272 V4. Backbone Creek, California.
272 W4. Upper Sacramento or Pitt River, California.
272 X4. McCloud River, California.
272 Y4. Squaw Valley Creek, California.

272. Sacramento River, California—Continued.

272 Z4. Squaw Creek, California.
272 A5. Montgomery Creek, California.
272 B5. Hatcher Creek, California.
272 C5. Burney Creek, California.
272 D5. Hot Creek, California.
272 E5. Spring Creek, California.
272 F5. Fall River, California.
272 G5. Bear Creek, California.
272 H5. Beaver Creek, California.
272 J5. Butte Creek, California.
272 K5. Clear Creek, California.
272 L5. Hot Spring Creek, California.
272 M5. Cold Spring Creek, California.
272 N5. Boiling Spring Creek, California.
272 O5. South Fork of Pitt River, California.
272 P5. Pine Creek, California.
272 Q5. Maddney Creek, California.
272 R5. Parkers Creek, California.
272 S5. Swearingen Creek, California.
272 T5. Goose Lake, California and Oregon.
272 U5. Davis Creek, California.
272 V5. Lassens Creek, California.
272 W5. Sugarloaf Creek, California.
272 X5. Dog Creek, California.
272 Y5. Slate Creek, California.
272 Z5. Castle Creek, California.

273. San Joaquin River, California.

273 A. Mokelumne River, California.
273 B. Cosumnes River, California.
273 C. Arkansas Creek, California.
273 D. Carsons Creek, California.
273 E. Little Indian Creek, California.
273 F. North Fork of Cosumnes River, California.
273 G. Cama Creek, California.
273 H. Deeks Springs, California.
273 J. Jackson Creek, California.
273 K. Jesu Maria Creek, California.
273 L. Calaveras River, California.
273 M. French Camp Creek, California.
273 N. Book Creek, California.
273 O. Lone Tree Creek, California.
273 P. Stanislaus River, California.
273. Q. Black Creek, California.
273. R. San Antonio Creek, California,
273. S. Six-mile Creek, California.

273. San Joaquin River, California—Continued,
- 273 T. Five-mile Creek, California.
- 273 U. Rose Creek, California.
- 273 V. Griswold Creek, California.
- 273 W. Tuolumne River, California.
    - 273 X. Dry Creek, California.
    - 273 Y. Arroyo Piedras, California.
    - 273 Z. Arroyo de la Puerto, California.
    - 273 A2. Coveslimba Creek, California.
- 273 B2. Merced River, California.
    - 273 C2. Dry Creek, California.
    - 273 D2. South Fork of Merced River, California.
        - 273 E2. Bishop Creek, California.
        - 273 F2. Chilnoine Creek, California.
    - 273 G2. Grouse Creek, California.
    - 273 H2. Indian Creek, California.
- 273 J2. Bear Creek, California.
    - 273 K2. Dry Creek, California.
    - 273 L2. Black Rascal Creek, California.
- 273 M2. Owens Creek, California.
- 273 N2. Chowchiila River, California.
- 273 O2. Fresno River, California.
    - 273 P2. Dry Creek, California.
    - 273 Q2. Dry Creek, California.
- 273 R2. Cottonwood Creek, California.
- 273 S2. Kings River Slough, California.
- 273 T2. Little Dry Creek, California.
- 273 U2. Willow Creek, California.
- 273 V2. Willow Creek, California.
- 273 W2. Kaiser Creek, California.
- 273 X2. Chiquito Juaquin, California.
- 273 Y2. Jackson Creek, California.

274. Russian River, California.
- 274 A. Pina Creek, California.
- 274 B. Galloway Creek, California.
- 274 C. McDonald Creek, California.

275. Gualala River, California.
- 275 A. Rock Pile Creek, California.

276. Garcia River, California.
277. Mill Creek, California.
278. Brush Creek, California.
279. Marsh Creek, California.
280. Alder Creek, California.
281. Elk Creek, California.
282. Greenwood Creek, California.

283. Navarro River, California.
 283 A. Indian Creek, California.
 283 B. Rancherie Creek, California.
284. Albion River, California.
 284 A. Salmon Creek, California.
285. Big River, California.
286. Rio Grande, California.
287. Noyo River, California.
288. Pudding River, California.
289. Beeddoc Creek, California.
290. Aluise Creek, California.
291. Hardy Creek, California.
292. Cottonwood Creek, California.
293. Mattole River, California.
294. Bear or Beale River, California.
295. Eel River, California.
 295 A. Lariby Creek, California.
 295 B. Dobyns Creek, California.
 295 C. Ke-Ka-wa Creek, California.
 295 D. North Fork of Eel River, California.
 295 E. Hull Creek, California.
 295 F. Salt Creek, California.
 295 G. Boulder Creek, California.
 295 H. Rice Creek, California.
 295 J. Little Stony Creek, California.
296. Elk River, California.
297. Freshwater Creek, California.
298. Jacobas Creek, California.
299. Mad River, California.
 299 A. Pilot Creek, California.
300. Little River, California.
301. Redwood Creek, California.
302. Klamath River, California.
 302 A. Blue Creek, California.
 302 B. Pequon Creek, California.
 302 C. Pine Creek, California.
 302 D. Trinity River, California.
 302 E. Mill Creek, California.
 302 F. John Creek, California.
 302 G. South Branch of Trinity River, California.
 302 H. Willows Creek, California.
 302 J. Madden River, Calfornia.
 302 K. Grouse River, California.
 302 L. Corral Creek, California.
 302 M. New River, California.
 302 N. Rattlesnake Creek, California.

302. Klamath River, California—Continued.
- 302 O. Big French Creek, California.
- 302 P. Little French Creek, California.
- 302 Q. Cañon Creek, California.
- 302 R. Weaver Creek, California.
- 302 S. Indian Creek, California.
- 302 T. Buckeye Creek, California.
- 302 U. Coffee Creek, California.
- 302 V. Bluff Creek, California.
- 302 W. Stale Creek, California.
- 302 X. Red Cap Creek, California.
- 302 Y. Camp Creek, California.
- 302 Z. Salmon River, California.
- 302 A2. Woolup Creek, California.
- 302 B2. Rock Creek, California.
- 302 C2. Dilons Creek, California.
- 302 D2. Elk Creek, California.
- 302 E2. Indian Creek, California.
- 302 F2. Scotts River, California.
- 302 G2. Humbug Creek, California.
- 302 H2. Grouse Creek, California.
- 302 J2. Shasta River, California.
- 302 K2. Little Shasta River, California.
- 302 L2. Cottonwood Creek, California and Oregon.
- 302 M2. Jennie Creek, California and Oregon.
- 302 N2. Butte Creek, California.
- 302 O2. Tule Lake, Oregon.
- 302 P2. Link River, Oregon.
- 302 Q2. Lower Klamath Lake, California and Oregon.
- 302 R2. Lost River, Oregon.
- 302 S2. Tule, or Modoc Lake, California.
- 302 T2. Upper Klamath Lake, Oregon, *vide* 303.

303. Upper Klamath Lake, Oregon.
- 303 A. Sprague River, Oregon.
- 303 B. Williams River, Oregon.
- 303 C. Klamath Marsh, Oregon.
- 303 D. Mutiney Creek, Oregon.
- 303 E. Moores Creek, Oregon.

304. Wilson's Creek, California.

305. Damnation Creek, California.

306. Smith's River, California.
- 306 A. South Fork of Smith's River, California.
- 306 B. Craighs Creek, California.
- 306 C. Rock Creek, California.

306. Smith's River, California—Continued.
- 306 D. Diamond Creek, California and Oregon.
  - 306 E. Rocky Creek, California.
- 306 F. Middle Fork of Smith's River, California.
  - 306 G. Monkey Creek, California.
- 306 H. North Fork of Smith's River, California and Oregon.
  - 306 J. Monkey Creek, California and Oregon.
  - 306 K. Indian Creek, California and Oregon.
  - 306 L. Succor Creek, California and Oregon.

307. Winchuck River, Oregon.
308. Chetcue River, Oregon.
309. Pistol Creek, Oregon.
310. Hunters Creek, Oregon.
311. Rogue River, Oregon.
- 311 A. Illinois River, Oregon.
  - 311 B. Cañon Creek, Oregon.
  - 311 C. Josephine Creek, Oregon.
  - 311 D. Althous Creek, Oregon.
- 311 E. Grave Creek, Oregon.
  - 311 F. Wolf Creek, Oregon.
- 311 G. Leland Creek, Oregon.
- 311 H. Louise Creek, Oregon.
- 311 J. Applegate Creek, Oregon.
  - 311 K. Slate Creek, Oregon.
- 311 L. Evans Creek, Oregon.
- 311 M. Sardine Creek, Oregon.
- 311 N. Stuart Creek, Oregon.

312. Yugua Creek, Oregon.
313. Savage Creek, Oregon.
314. Elk Creek, Oregon.
315. Sixes Creek, Oregon.
316. Coquille River, Oregon.
317. Coos River, Oregon.
318. Ten-mile River, Oregon.
319. Umpquah Elk Creek, Oregon.
- 319 A. Smiths River, Oregon.
- 319 B. Scholfelds Creek, Oregon.
- 319 C. River Laurelo, Oregon.
  - 319 D. Calapooa Creek, Oregon.
  - 319 E. North Umpquah River, Oregon.
  - 319 F. Deer Creek, Oregon.
  - 319 G. Muddle Creek, Oregon.
  - 319 H. Cow Creek, Oregon.

320. Tsilicoos River, Oregon.
321. Sinslaw River, Oregon.
322. Ya Chats River, Oregon.

323. Alsea River, Oregon.
324. Little Elk Creek, Oregon.
325. Nekas River, Oregon.
326. Nechesne River, Oregon.
327. Nestuggah River, Oregon.
328. Nawuggah River, Oregon.
329. Tracks River, Oregon.
330. Wilsons River, Oregon.
331. Nehalem River, Oregon.
332. Columbia River, Oregon and Washington.
332 A. Lewis and Clarke River, Oregon.
332 B. Grays River, Washington.
332 C. Days Creek, Oregon.
332 D. Cowlitz River, Washington.
332 E. Coweman River, Washington.
332 F. Traders River, Washington.
332 G. Arkansas Creek, Washington.
332 H. Toutle River, Washington.
332 J. Tilton River, Washington.
332 K. Kalama River, Washington.
332 L. Jones Creek, Oregon.
332 M. Lewis River, Washington.
332 N. Salmon River, Washington.
332 O. Cathlappotle River, Washington.
332 P. WILLAMETTE RIVER, Oregon, *vide* 333.
332 Q. Sandy River, Oregon.
332 R. Washington River, Washington.
332 S. Rock Creek, Washington.
332 T. Wind River, Washington.
332 U. White Salmon River, Washington.
332 V. Klikitat River, Washington.
332 W. Wowumche River, Washington.
332 X. Deschutes River, Oregon.
332 Y. Cherry Creek, Oregon.
332 Z. White River, Oregon.
332 A2. John Day River, Oregon.
332 B2. Rock Creek, Oregon.
332 C2. Barrel Creek, Oregon.
332 D2. Willow Creek, Oregon.
332 E2. Umatilla River, Oregon.
332 F2. Butter Creek, Oregon.
332 G2. Birch Creek, Oregon.
332 H2. Hautomah Creek, Oregon.
332 J2. Touchel River, Washington.
332 K2. Dry Creek, Washington.
332 L2. Mill Creek, Washington.

332. Columbia River, Oregon and Washington—Continued.

332 M2. Copper Creek, Washington.

332 N2. Whiskey Creek, Washington.

332 O2. SNAKE RIVER, Washington, Oregon, Idaho, and Wyoming, *vide* 334.

332 P2. Yakima River, Washington.

332 Q2. Tattaha Creek, Washington.

332 R2. Pisco River, Washington.

332 S2. Attanam River, Washington.

332 T2. Nachess River, Washington.

332 U2. Wenass River, Washington.

332 V2. Etenam Creek, Washington.

332 W2. Colonel Anderson's Creek, Washington.

332 X2. Upper Yakima River, Washington.

332 Y2. Kleallun Lake, Washington.

332 Z2. Pisquause or Wenatchapam River, Washington.

332 A3. Wenatchapam Lake, Washington.

332 B3. Ente-at-kwa River, Washington.

332 C3. Methow River, Washington.

332 D3. Okinakane River, Washington.

332 E3. Hy-os-kwa-ha-loos Creek, Washington.

332 F3. Nespotum Creek, Washington.

332 G3. Sanboila River, Washington.

332 H3. Spokane River, Washington.

332 J3. Chemekane Creek, Washington.

332 K3. Little Spokane River, Washington.

332 L3. Hangmans Creek, Washington and Idaho.

332 M3. Coeur D'Aléne Lake, Idaho.

332 N3. Saint Joseph River, Idaho.

332 O3. Cœur D'Aléne River, Idaho.

332 P3. Straunteus River, Washington.

332 Q3. Sehlowskap Creek, Washington.

332 R3. Kitsomswhe Creek, Washington.

332 S3. Kettle River, Washington.

332 T3. CLARKE'S FORK OF COLUMBIA RIVER, Washington, Idaho, and Montana, *vide* 335.

333. Willamette River, Oregon.

333 A. Clear Creek, Oregon.

333 B. Eagle Creek, Oregon.

333 C. Clackamas River, Oregon.

333 D. Molalla River, Oregon.

333 E. Pudding River, Oregon.

333 F. Butte Creek, Oregon.

333 G. Silver Creek, Oregon.

333 H. Salt Creek, Oregon.

333 J. Luckiamute River, Oregon.

333. Willamette River, Oregon—Continued.
- 333 K. Santiam River, Oregon.
  - 333 L. South Fork of Santiam River, Oregon.
- 333 M. Calanooga River, Oregon.
- 333 N. Long Tom River, Oregon.
- 333 O. Simmons McKenzie River, Oregon.
  - 333 P. Mohawk Creek, Oregon.
  - 333 Q. Camp Creek, Oregon.
  - 333 R. Gale Creek, Oregon.
- 333 S. Spencer Creek, Oregon.
- 333 T. Lost Creek, Oregon.
- 333 U. Fall Creek, Oregon.
  - 333 V. Kelley's River, Oregon.
  - 333 W. Summit Lake, Oregon.

334. Snake River, Washington, Idaho, and Wyoming.
- 334 A. Cherana River, Washington.
  - 334 B. Lake Hays, Washington.
  - 334 C. Pelouse River, Washington and Idaho.
    - 334 D. Smoke Creek, Washington.
    - 334 E. Oraytyayous River, Washington.
      - 334 F. Rock Creek, Washington.
    - 334 G. Tinatpanup River, Washington and Idaho.
- 334 H. Tukannon River, Washington.
- 334 J. Alpowa Creek, Washington.
- 334 K. Clearwater River, Idaho.
  - 334 L. Sweetwater Creek, Idaho.
  - 334 M. Lapway Creek, Idaho.
  - 334 N. Paluse Creek, Idaho.
    - 334 O. Hatowaii Creek, Idaho.
  - 334 P. North Fork of Clearwater River, Idaho.
    - 334 Q. Moose Creek, Idaho.
  - 334 R. Lowget Creek, Idaho.
  - 334 S. Oro Fino Creek, Idaho.
    - 334 T. Rhodes Creek, Idaho.
  - 334 U. Lolo River, Idaho.
  - 334 V. Middle Fork of Clearwater River, Idaho.
  - 334 W. South Fork of Clearwater River, Idaho.
    - 334 X. Red River, Idaho.
      - 334 Y. Crooked Creek, Idaho.
- 334 Z. Assotin Creek, Washington.
- 334 A2. Looking-glass Creek, Washington.
- 334 B2. Grand Ronde River, Washington and Oregon.
  - 334 C2. Willow Creek, Oregon.
  - 334 D2. North Fork of Grand Ronde River, Oregon.
  - 334 E2. Hot Lake, Oregon.

334. Snake River, Washington, Idaho, and Wyoming—Continued.

334 F2. Salmon River, Idaho.
334 G2. White Bird Creek, Idaho.
334 H2. Slate Creek, Idaho.
334 J2. Pioneer Creek, Idaho.
334 K2. Little Salmon River, Idaho.
334 L2. Elk Creek, Idaho.
334 M2. French Creek, Idaho.
334 N2. Woods Creek, Idaho.
334 O2. Meadow Creek, Idaho.
334 P2. Rock Creek, Idaho.
334 Q2. Stradon Creek, Idaho.
334 R2. Steamboat Creek, Idaho.
334 S2. Elk Creek, Idaho.
334 T2. Secesh Creek, Idaho.
334 U2. Cliff Creek, Oregon.
334 V2. Powder River, Oregon.
334 W2. Eagle Creek, Oregon.
334 X2. Burnt River, Oregon.
334 Y2. Weiser River, Idaho.
334 Z2. Indian Creek, Idaho.
334 A3. Malheur River, Oregon.
334 B3. Willow Creek, Oregon.
334 C3. Rock Creek, Oregon.
334 D3. Payette River, Idaho.
334 E3. Boise River, Idaho.
334 F3. Grimes Creek, Idaho.
334 G3. Thorn Creek, Idaho.
334 H3. Moores Creek, Idaho.
334 J3. Elk Creek, Idaho.
334 K3. Beaver Creek, Idaho.
334 L3. South Boise River, Idaho.
334 M3. Dixie Creek, Idaho.
334 N3. Fall Creek, Idaho.
334 O3. Little Camas Creek, Idaho.
334 P3. Wood Creek, Idaho.
334 Q3. Lime Creek, Idaho.
334 R3. Dog Creek, Idaho.
334 S3. Steel Creek, Idaho.
334 T3. Middle Boise River, Idaho.
334 U3. Roaring River, Idaho.
334 V3. Queens River, Idaho.
334 W3. Yuba River, Idaho.
334 X3. North Fork of Boise River, Idaho.
334 Y3. Owyhee River, Oregon and Nevada.
334 Z3. Jordan River, Oregon and Idaho.

334. Snake River, Washington, Idaho, and Wyoming—Continued.

334 A4. Crooked or Antelope Creek, Oregon.
334 B4. Bull Run Creek, Nevada.
334 C4. Reynolds Creek, Idaho.
334 D4. Squaw Creek, Idaho.
334 E4. Cañon Creek, Idaho.
334 F4. Grave Creek, Idaho.
334 G4. Burnt Mountain Creek, Idaho.
334 H4. Bruneau River, Idaho and Nevada.
334 J4. Syrup Creek, Idaho.
334 K4. Indian Creek, Idaho.
334 L4. Squaw Creek, Idaho.
334 M4. Clover Creek, Idaho.
334 N4. Salmon Fall Creek, Idaho.
334 O4. Wood River, Idaho.
334 P4. Malade River, Idaho.
334 Q4. Salmon Fall River, Idaho.
334 R4. Rock Creek, Idaho.
334 S4. Goose Creek, Idaho and Nevada.
334 T4. Raft River, Idaho and Nevada.
334 U4. Fall Creek, Idaho.
334 V4. Bannack River, Idaho.
334 W4. Port Neuf River, Idaho.
334 X4. Willow Creek, Idaho.
334 Y4. South or Lewis Fork of Snake River, Idaho.
334 Z4. John Grays River, Idaho and Wyoming.
334 A5. Salt Creek, Wyoming.
334 B5. Gros Ventres Creek, Idaho and Wyoming.
334 C5. Jacksons Lake, Idaho.
334 D5. Heart Lake, Wyoming.
334 E5. Madison Lake, Wyoming.
334 F5. De Lacy Lake, Idaho.
334 G5. Teton River, Idaho.

335. Clarke's Fork of Columbia River, Washington, Idaho, and Montana.

335 A. Kaniksu Lake, Idaho.
335 B. Lake Pend O'Reille, Idaho.
335 C. Pack River, Idaho.
335 D. Elk Creek, Montana.
335 E. Bull River, Montana.
335 F. Camp Creek, Montana.
335 G. Vermillion Creek, Montana.
335 H. Beaver Creek, Montana.
335 J. Deep Creek, Montana.
335 K. Grave Creek, Montana.

335. Clarkes Fork of Columbia River, Washington, Idaho, and Montana—Continued.
- 335 L. Prospect Creek, Montana.
- 335 M. Thompson's River, Montana.
  - 335 N. Lake Ashley, Montana.
- 335 O. Five-mile Creek, Montana.
- 335 P. Flat Head River, Montana.
  - 335 Q. Jocko River, Montana.
    - 335 R. Finlay Creek, Montana.
  - 335 S. Soncilem Creek, Montana.
    - 335 T. Crow Creek, Montana.
  - 335 U. Hot Spring Creek, Montana.
  - 335 V. Flat Head Lake, Montana.
  - 335 W. Swan River, Montana.
  - 335 X. Maple River, Montana.
- 335 Y. MISSOULA RIVER, Montana, *vide* 336.

336. Missoula River, Montana.
- 336 A. Saint Regis Borgia River, Montana.
- 336 B. Oregon Gulch Creek, Montana.
  - 336 C. Cedar Creek, Montana.
- 336 D. Fishery Creek, Montana and Idaho.
- 336 E. Skyote Creek, Montana.
- 336 F. Bitter River, Montana.
  - 336 G. Eight-mile Creek, Montana.
  - 336 H. Burnt Fork of Bitter River, Montana.
  - 336 J. Gird's Creek, Montana.
  - 336 K. Skalkaho Creek, Montana.
  - 336 L. Weeping Child Creek, Montana.
- 336 M. Big Blackfoot River, Montana.
  - 336 N. Elk Creek, Montana.
  - 336 O. Nevada Creek, Montana.
- 336 P. Stony Creek, Montana.
  - 336 Q. Little Stony Creek, Montana.
  - 336 R. Willow Creek, Montana.
- 336 S. Hellgate River, Montana.
  - 336 T. Bear Creek, Montana.
  - 336 U. Flint Creek, Montana.
    - 336 V. Gold Creek, Montana.
    - 336 W. Willow Creek, Montana.
    - 336 X. Trout Creek, Montana.
  - 336 Y. Willow Creek, Montana.
  - 336 Z. Deer Lodge River, Montana.
    - 336 A2. Rock Creek, Montana.
    - 336 B2. Tin-Cup Joe Creek, Montana.
    - 336 C2. Cottonwood Creek, Montana.
    - 336 D2. Demsey Creek, Montana.

336. Missoula River, Montana—Continued.
- 336 E2. Oro Fina Creek, Montana.
- 336 F2. Track Creek, Montana.
- 336 G2. Chance Creek, Montana.
- 336 H2. Hot Spring Creek, Montana.
- 336 J2. Red Creek, Montana.
- 336 K2. Basin Creek, Montana.
- 336 L2. Cataract Creek, Montana.
- 336 M2. Hyora Creek, Montana.
- 336 N2. Boomerang Creek, Montana.
- 336 O2. Little Blackfoot River, Montana.
- 336 P2. Dog River, Montana.

337. Shoal Water Bay, Washington.
- 337 A. Bear River, Washington.
- 337 B. Nesal River, Washington.
- 337 C. Maho River, Washington.
- 337 D. Palux River, Washington.
- 337 E. North River, Washington.

338. Grays Harbor, Washington.
- 338 A. Satsop River, Washington.
- 338 B. Wynootchee River, Washington.
- 338 C. Wishkah River, Washington.
- 338 D. Hoquiam Creek, Washington.
- 338 E. Hum-tu-lups River, Washington.

339. Copalis Creek, Washington.

340. Quinaiult River, Washington.
- 340 A. Quinaiult Lake, Washington.

341. Raft River, Washington.

342. Quiets River, Washington.

343. Shahlett River, Washington.

344. Quilleute River, Washington.

345. Tsooyers Creek, Washington.

346. Strait San Juan de Fuca, Washington.
- 346 A. Camel River, Washington.
- 346 B. Lure River, Washington.
- 346 C. Elwha River, Washington.
- 346 D. Dungeness River, Washington.
- 346 E. Salmon River, Washington.
- 346 F. Puget Sound, Washington.
- 346 G. Suquamish River, Washington.
- 346 H. Nisqually River, Washington.
- 346 J. Tanwar River, Washington.
- 346 K. Tanwar Lake, Washington.
- 346 L. Owhap Lake, Washington.
- 346 M. Puyallup River, Washington.
- 346 N. Dwamish Lake, Washington.

346. Strait San Juan de Fuca, Washington—Continued.

346 O. Dwamish River, Washington.
346 P. Cedar River, Washington.
346 Q. Samamish Lake, Washington.
346 R. Samamish River, Washington.
346 S. Snohomish River, Washington.
346 T. Snogualmie River, Washington.
346 U. Stiliquamish River, Washington.
346 V. Skagit River, Washington.
346 W. Tekulla River, Washington.
346 X. Sokh River, Washington.
346 Y. Squ-al-i-cum Creek, Washington.
346 Z. Nooksachk River, Washington.
346 A2. Sehkamehkl Greek, Washington.
346 B2. Callam Creek, Washington.

NOTE.—The following corrections should be made in the foregoing list:

Under 11, insert 11 D. Ellis River, New Hampshire.
Under 33 K, omit Rush Branch, Rhode Island.
Under 38 B, read Usquebaug River, Rhode Island.
Under 102 M, read Lake Eustis, Florida.
Under 110 C, read Kissimee River, Florida.
Under 110 E, read Lake Kissimee, Florida.
Under 147, read Chefunctee River, Louisiana.
Under 147 A, Bayou Phalia, Louisiana.
Under 151 B3, read Bourbeuse River, Missouri.
Under 152 A, Atchafalaya River, Louisiana.
Under 156 Q2, read Salamonie River, Indiana.
Under 156 T9, read French Creek or Venango River, Pennsylvania.
Under 158 N, Barton's Creek, Tennessee.
Under 163 F, read Elkhorn Creek, Illinois.
Under 164 X5, omit Niorbrara River, Wyoming.
Under 166 F3, read Deer Trail Creek, Colorado.
Under 174 J2, read Big Panther Creek, Illinois.
Under 180 C & D, for Aux Plain read Eau Pleine.

APPENDIX B.

THE FISHERIES.

VIII.—NOTES UPON THE HISTORY OF THE AMERICAN WHALE FISHERY.

By F. C. Sanford.

It is not my purpose to go back to the time when whaling was first carried on by the Biscayans, or speak particularly of a later period when England and Holland were engaged in the business, 1598–1611. At this time the Dutch sent one hundred and thirty-three whalers to Spitzbergen, and up to 1782 had captured thirty-three thousand Greenland whales, whose money value was computed at $100,000,000. These notes have reference to a still later period, relating more especially to the business as carried on in our own country, commencing, perhaps, with the time of John Smith (of Pocahontas memory), when whales were captured along the coast of Maine, the undertaking being attended with great difficulty. Of these voyages there is comparatively little known. In 1670, William Hamilton succeeded in taking the first spermaceti whale off Nantucket, and from that time for nearly two hundred years Nantucket successfully pursued the business. It had increased to such dimensions in this and other towns in the State that, in a little over a hundred years, about 1775, Mr. Jefferson made an elaborate report to Congress upon the whale fishery of Massachusetts, and commended it as an enterprise worthy of the fostering care of the Government as a nucleus for American seamen alone. See "Pitkin's Reports."

That our people carried on regularly the business of whaling from the shore in boats as early as 1670, is shown by the following extract from the town records:

"At a town meeting of the trustees, 1693, it was agreed that the pines and undivided wood on Coatue be divided to every man his proportion as soon as it can be with convenience, and until or before that be done, no man shall cut or carry away off the land the said wood, on penalty of five shillings for every load cut or carried away. *Nevertheless*, any freeholder may cut timber for *whale-boats*, or the like, anything on this order to the contrary notwithstanding."

I find, also, by a letter signed by Nathaniel Coffin, son of James, dated June 16, 1699, at Saint Johns, N. F., on board one of our vessels, that they were on a whaling expedition, and had put in there for recruits, which shows that the making of comparatively long voyages was commenced at a much earlier period than is generally supposed.

In 1783 a number of our people, entertaining an idea that the island would not support its increasing population, purchased, with others from Providence and Newport, R. I., and Martha's Vineyard, of Peter Hogeboon, jr., and others, what was then known as Claverack Landing,* above New York, on the Hudson River. The name was changed to "Hudson" the succeeding year. As early as 1784 many families removed thither from Nantucket, and among them was Alexander Coffin, a famous London packet commander, and a man of sterling worth. Captain Coffin was in Paris at the time of the negotiations between Dr. Franklin and the French Government, pending the treaty between that power and America, and was intrusted by Dr. Franklin with his dispatches to the Continental Congress, then sitting in Philadelphia, announcing his success the instant it was assured. As is well known, Captain Coffin faithfully executed the trust reposed in him. Nathan Coffin, of whom Bancroft (vol. 9, p. 313) speaks as a "hero," was also among those who emigrated to Hudson. He was grandfather of Charles H. Marshall, who established in New York the renowned "Black Ball Line" of Liverpool packets. And then there were the Paddocks, Barnards, Jenkinses, Gardners, Folgers, Husseys, Worths, Macys, Starbucks, Cartwrights, in whose veins ran some of the best blood of the island. Soon after the settlement of Hudson the business of whaling and sealing upon Chili was commenced, but it was unsuccessful from the start and was soon abandoned. Notwithstanding the ill-success of their first venture, the people of Hudson, in 1830, again attempted to carry on the business, and procured from Nantucket a number of men for the undertaking. The ships Edward, Martha, Alex. Mansfield, Beaver, America, Henry Astor, Huron, George Clinton, and James Monroe were fitted and sent out. The America returned from the Pacific with upwards of three thousand barrels of sperm oil. Poughkeepsie also dispatched ships, N. P. Talmage, Russell, New England, Vermont, and others. After several voyages, both towns abandoned the business. Newbury had a similar experience, sending out the ships North America, Newark, and Russell. In 1817, the city of New York had a hand in the game. Previous to that time Thomas Hazard, esq., had operated from New Bedford, and associated himself with Jacob Barker, his son-in-law, sending out the ships Eliza Barker and Diana, followed soon after by the William Tell, Mobile, Trident, and others. Jacob Barker sent many of his own ships also, always with Nantucket commanders. The business was carried on but a very short time, and the ships were sold tc New Bedford.

The whaling from Sag Harbor was commenced with small vessels soon after the American Revolution. Again in 1815, after peace with England, the business was renewed with ships of 300 tons, which were built, or bought new. Capt. Stephen Skinner, of the ship Indian Chief, and others

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* Dutch *Klauffer-acht,* meaning eight hills or cliffs.

of the Nantucket commanders were engaged for these important enterprises. The voyages were usually crowned with success. From small beginnings Sag Harbor became a great center for whaling, and she maintained a successful fleet, both in the sperm and right whale fishery, until the "gold fever" developed itself in 1848.

Among the enterprising merchants of this port at the end of Long Island were to be found the Howells, Slates, Mulfords, Huntingtons, Posts, Deerings, and Sherrys, and its noble race of shipmasters was second to none on the continent. In September, 1800, some merchants of Norwich and New London sent the twenty-gun ship Oneida, Captain Hubbell, to the coast of Chili on a sealing expedition, building and sending out immediately the ship Miantonomoh to the South Pacific Ocean, in charge of Valentine Swain, of Nantucket, on a whaling and sealing voyage. After securing cargoes the ships were to proceed to Canton, dispose of the oil and skins and take for the returned voyage to the United States teas, silks, and nankeens. In 1802 the Miantonomoh was captured and condemned by the Spaniards at Valparaiso. Nantucket lost one of her ships about the same time, which was engaged in whaling and sealing, as the former had been. She was named the Trial, and was commanded by Thomas Coffin, the father of the late lamented Lucretia Mott. Nothing was ever recovered from them. We had many others in the same employment, Lady Adams, Brothers, Favorite, Mars, Minerva, &c. The latter ship was commanded by Mayo Folger,* who was afterwards master of the Topaz, which belonged to himself and others in Boston. On one of his voyages in the Topaz, September, 1808, he discovered Pitcairn's Island, where he found the survivors of the Mutineers of the Bounty. This was the first knowledge the world had of the fate of these men since Bligh was set adrift in mid ocean eighteen years before. Upon Captain Folger's arrival in Valparaiso he communicated the news to the British admiral, who immediately dispatched a swift vessel to England with the facts. It created intense excitement at the time.

But to return to New London. In 1805 they bought and sent the ship Dauphin, Capt. Laban Williams, to Brazil Banks, and obtained a small voyage. This may be considered the commencement of whaling here, New London. Then they purchased the ship Leonidas, and both ships, she and the Dauphin, were fitted and sailed in August, 1806, the former commanded by Alexander Douglass, and the latter by Captain Williams. In 1807 both arrived with full cargoes of whale oil, one having about 700 barrels and the other 1,050. The ship Lydia was then purchased and the command given to Captain Douglass. The Dauphin was given to Joshua Sayer, of Nantucket, and the Leonidas to William

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* It might not be out of place in this connection to mention the fact that Capt. Mayo Folger was brother of the above-mentioned Capt. Thomas Coffin's wife, who was, of course, the mother of Lucretia Mott. Captain Folger was postmaster at Massalon, Ohio, and died there in 1828.

Barnes. All of the ships came home full in 1808, the first with 900 barrels of whale oil, the second with 1,000, and the third with 1,200. They were then sold to other ports and not much more was done until 1821, when they commenced anew by fitting out the ship Carrier, Obed Swain, of Nantucket, for the Pacific Ocean. She returned in 1823 with 2,074 barrels of sperm oil, having been absent twenty-eight months. From this date the merchants of New London put forth all their energies and the town became the third whaling port in the United States, and it may be proud of its record in the pursuit and development of this branch of national industry, as well as of its opulent merchants and capitalists, among whom are the Barnes, Browns, Billings, Lawrences, Smiths, Hovens, Perkins, Debones, Funks, Fitches, Williams, Hanus, and many others.

The ship Thames, Capt. Reuben Clasby, of Nantucket, sailed in October, 1822, from New Haven for the Pacific Ocean, having on board the first missionaries for the Sandwich Islands. Revs. Mr. Bingham, Williams, Charles Stewart, and others, with their wives. They landed at Oahu and Lapina in May, 1823. The ship Helena, Capt. Naiah Coffin, of Nantucket, also sailed from New Haven for the Pacific. Both ships came home with full cargoes of sperm oil from the coast of Japan, but oil was worth only 38 cents per gallon and the ships were sold to Sag Harbor. Stonington, Mystic, and Bridgeport came along with a successful fleet of whalers, all of which have made quite as big claims as any of the older peoples in this service.

New York, Hudson, Cold Spring, and Greenport have had their day at New Zealand, Falkland Islands, and the Northwest coast. Poughkeepsie, and Wilmington on the Delaware, have had their trials in the game, but of comparatively recent date, and soon abandoned it.

In 1820 Warren, R. I., fitted out the new ship Rosalie, Capt. David Easton, of Nantucket. This ship was followed by some of the finest that could be built or bought out of the China or cotton trade, until it was but little behind her neighbors in Connecticut. Bristol followed in 1827, with the Ganges, purchased in Boston, and the Bowditch, a Boston East Indiaman, both ships being commanded by Nantucket men. The Leonidas, Captain Lawton, came immediately after, and large sperm whale voyages were obtained by all these ships. Then were added the famed Corinthian, and the Balance, and James Dewolf's teak ship, General Jackson. The Balance and General Jackson were captured in the war of 1812, and the latter renamed for the hero of New Orleans. She was one hundred and fifty years old when retired from service, the other ninety years old.

Providence, R. I., merchants added a few ships to the sperm whaling grounds, and also to the Arctic fleet, among them the Liverpool packet ship South America, the splendid ship Brutus, &c.

In 1820 Newport, R. I., fitted out her first whale ships, Frederick Augustus, Capt. Joseph Earl; Robinson Potter, Capt. Reuben Swain;

Carrier, Capt. William Fitzgerald—all the captains hailing from Nantucket. These ships went to the Pacific Ocean, and in due season returned filled with sperm oil. From this beginning sprang quite a numerous fleet of sperm whalers, which was maintained until the decline of whaling in 1850.

As early as the year 1755 New Bedford had a sloop or two engaged in whaling, and between that and 1765 two or three more were fitted out from Dartmouth, as New Bedford was then called. In 1791 the ship Rebecca, Captain Halsey, was sent into the Pacific. In 1795 the Rotches and Rodmans, having left their island home and selected New Bedford as their future abiding place, employed a number of ships independent of their French fishery; but it was not until 1820 that the business assumed any great proportions. In that year the whale fishery was taken up and prosecuted with great spirit, the influx of new elements, both in ownership and masters, not only from Nantucket, but every part of New England, added greatly to the movement. After 1830 the great and brilliant voyages of its Braganzas, Magnolias, George Howlands, Parkers, William Hamiltons, Emeralds, and Reindeers, gained in the Pacific Ocean, gave to New Bedford a period of success, made it a tower of strength, and secured for its merchants a reputation not easily attained at the present day. New Bedford still pursues the business with considerable vigor in every part of the globe where it has been found remunerative. Fair Haven, opposite New Bedford, Westport, and Fall River, have all come to number some of the finest ships in their fleets, but, alas, all that spirit may be said to have gone into new channels, more productive of success. *Ichabod* is written on the pillars of their ports.

Boston, in 1820, had her William Gray and Israel Thorndike, and they fitted out for the Pacific Ocean the ships Cadmus, Nathaniel C. Cary, Beverly, Elias Suley, Hope, Jethro Coffin, Palladium, Alexander Macy, all the captains being Nantucket men. These ships all filled with sperm oil and returned to Boston. Oil commanding but 33 cents* a gallon, the owners became discouraged and sold the ships. The Beverly was sold into the merchant service, and was burned at sea, off Pernambuco on a voyage to Peru with a valuable cargo, in 1826. The rest of the fleet were whalers for many years after. But few other whale ships have since been fitted at Boston, hardly enough to make mention of, with the exception perhaps of the Herald and Charles Carroll, fitted in 1833.

Salem, Plymouth, Newburyport, Mass., Portsmouth, N. H., and Wis-

* Sperm oil has since been sold as high as $2.40 a gallon. The oil of the ships above mentioned was purchased here at Nantucket by Aaron Mitchell, and from its sale to another firm, Messrs. Gardner & Swift, of this place, grew up the great lawsuit in 1826, known as the "Gardner and Swift case." Hon. Daniel Webster was retained by the Quaker in this and all other business where said Gardner was a party, receiving for his services a fee of $10,000. The old Quaker employed Mr. Webster in two ship cases then in litigation at Nantucket with insurance offices.

casset, Me., have in the years mentioned, say from 1820 to 1850, turned many of their old East Indiamen, China, cotton, and pepper ships, and European packets into whalers. Some have been successful, but as a general thing the business has declined, the ships have been sold and finally brought up in some far-away port, mostly San Francisco—there to be broken up, and their iron and copper used as a circulating medium, perhaps, in the inner waters of the Chinese Empire.

Nantucket has made its honorable mark in every sea where a vessel could go in pursuit of wealth. A nobler record cannot be shown, and here it must rest, I fear, forever.

In 1785 Mr. William Rotch went to London, and there waited four months upon George III and William Pitt and his council, subject to the call of Pitt at any time. Lord Hawkesbury at length gave him a hearing, but would not listen to Rotch's proposition to bring twenty ships from America with all their material for whaling and enter them free of duty. Mr. Rotch, tired of waiting, and, getting no satisfaction from Hawkesbury, left England on the ship Maria for Dunkirk, France. On his arrival in Paris he was granted an early interview by the French minister, who agreed to admit his ships; and, in fact, agreed to all Mr. Rotch demanded, and the business was soon in successful operation. His ships were dispatched to the Pacific, coast of Africa, and Falkland Islands. On the 1st of February, 1792, the ship Falkland, Capt. Obed Paddock, arrived at Dunkirk filled with sperm oil. A week later the Harmony, Capt. David Starbuck, arrived with a full cargo from Peru. These ships* were among the first that obtained sperm-oil in the Pacific Ocean, and that, too, just under the peaks of the Andes (1789–'92). What would Burke have said to that achievement, doubling the stormy cape, and so down to Peru, in the most temperate climate man has yet known? The Harmony was afterwards (1796) sunk by a whale on Brazil Banks, which leaped on board in the night. The crew were all saved, being taken on board the ship Leo, of Nantucket. Abel Rawson was in command of the Harmony at the time. This Captain Rawson kept the Staten Island Light, New York, as late as 1826.

So soon as the British ministry heard that Mr. Rotch and his son Benjamin had left London for France, Lord Hawkesbury sent a courier with dispatches to recall him. On his return to London Mr. Rotch met Mr. Pitt and Lord Hawkesbury, who agreed to allow him to bring thirty ships from America, but Rotch informed him that it was too late, as he had agreed to go to France. The ministry, being dissatisfied with Hawkesbury, desired that Mr. Rotch should give them a detailed account in writing of the whole circumstances, in order that when Parliament met the matter might be laid before them. Mr. Rotch refused, as he did not wish to be instrumental in creating or aiding an opposition

* These two ships rendezvoused at Callao, Peru, together with the ship Columbia, of Boston, Captain Gray, who had, in this his second voyage, in 1792, just discovered the Columbia River on the northwest coast.

among the ministry; and thus the matter ended. When the French revolution broke out the Rotchs accepted certain terms from the English Government, and went to Milford Haven with part of their ships. After the revolution in France the Rotch's had two fleets of whalers, one sailing from England, the other from France, and this continued until the death of Mr. Benjamin Rotch in London in 1839. The French fleet continued in existence until the death of Mr. William R. Rodman, a grandson of Mr. Rotch, which event occurred in 1855, the business thus remaining in the family for seventy years, and passing from grandfather to grandson.

While in France Mr. Rotch appeared in the French assembly with a petition for a modification of the conscription and Maniago laws, which should favor the Friends or Quakers, many of whom had emigrated from Nantucket with their families to France. He was listened to with marked attention by all who were in the assembly. Mirabeau was chosen to reply to him, and it was a masterly effort. Edward Everett is quoted as saying that it was the best speech he ever made.

During the war of 1812 Nantucket was attacked at home and abroad. England kept her Scorpions, Nimrods, and Bulldogs hovering around the island, capturing everything inward or outward bound. At times the inhabitants were in extreme distress for want of the bare necessaries of life. When peace was declared in February, 1815, there was an unusual demonstration and great rejoicing among the people. The ocean was once more open and free to their ships, and they were not long in sending to sea a new and extensive fleet. We soon had a large number upon Chili, Peru, and what was known as the "off-shore" whaling ground, which extended from near the equator as far west as the Society and Navigator's group of islands. But whales had become scarce, and the oily monstors must be sought after in new seas. In 1820, the ships Maro and Rambler, of Nantucket, commanded, respectively, by Capts. Joseph Allen and Benjamin Worth, in company with the Syren, of London, belonging to Samuel Enderly, Capt. Fred. K. Coffin; Cyrus, Capt. Elisha Folger, jr., and Balena, Capt. Edmund Gardner, of New Bedford, rendezvoused at the Sandwich Islands. Here they met Captain Winship, of the ship O'Cane, a veteran northwest coast merchantman, who informed them that while crossing on his many voyages from the Sandwich Islands to Canton, China, he observed a great number of sperm whales on what was called the Coast of Japan, in latitude 25° north, longitude 165° east, even up to the Japan Islands. Convinced that the enthusiastic statements of Captain Winship could be relied upon as facts, the several captains hurriedly recruited their ships and sailed into these unfrequented seas. Two of the fleet arriving off the coast of Japan, in the spring of 1820, on the 10th day of May Captain Coffin in the Syren saw and struck his first sperm whale; Captain Allen, in the ship Maro, of Nantucket, struck the next whale June 1, and both ships were filled with sperm oil in three months after leaving the Sandwich Islands, each ship taking upwards of 1,800 barrels.

The other ships sailed a little to the northward of the Sandwich Islands, meeting good success, coming east and filling up off Cape Saint Lucas, California. All the ships returned home with great cargoes.

We doubt if Nantucket ever, before or since, produced the superiors of these five men in intellect or daring. They were all natives of the island, and after their retirement from the sea lived to great ages, two of them reaching ninety-two years, and the others from seventy-eight to eighty-five years. Each of them had brilliant careers. It was from such men as these that Mr. Seward obtained his information when preparing his great speech asking for Government aid in surveying Behring Strait. His speech was delivered in the United States Senate in 1852. In it he made glowing allusion to the enterprise and daring of Nantucket whalemen. Many of our sea captains after their retirement from active labor settled in and around Auburn, and became neighbors of the great Senator, Capt. Fred. Coffin being of the number.

Captain Winship remarked to the writer in the spring of 1835, that he had seen great numbers of sperm whales on the northwest coast, off Kodiac, while passing to the Sandwich Islands, and was certain that they were spermaceti species. Being convinced that there was something to be made out of this, we fitted out the ship Ganges and sent her, in the summer of 1835, to the locality mentioned, in charge of Barzallia T. Folger. In his first report which we received from there, Captain Folger stated that he had seen nothing but right whales. As whale oil and bone were of little value at that period, and as he did not care to lower his boats for them, he had, after taking 300 barrels, dropped down the coast to Pudder Bay, California. The next season, however, he filled his ship with sperm oil off the coast of Japan. The French ship Ville de Lyon, of Havre, was the next upon the northwest coast. She also was successful, and was followed in 1840 by the Elbe, Captain Waterman, of Poughkeepsie, N. Y., which ship returned home with a full cargo of whale and sperm oil. Since that date whale fishing on the northwest and sea coast of Japan has been prosecuted with wonderful vigor by every place that had a ship to send to sea.

Previous to the voyage to Japan in 1820, before mentioned, Captain Coffin, while making a voyage to the eastward of Cape of Good Hope in the same ship, Syren, met with an adventure which came near proving fatal to the whole crew. On a fine day, while near one of the Pilew Islands, all the boats being from the ship in pursuit of whales, and but a small number of men remaining on board, she was taken forcible possession of by the natives of those islands, who drove the men into the rigging for safety. The ship and all on board were now in a perilous position. These naked and howling savages had full command of the ship. When the mate came alongside he comprehended the situation at a glance, and immediately gave orders for the men in the top to open the arm-chests and scatter all the tack-nails they could find down upon the deck. This was promptly done, and the nails poured

down like rain upon the heads of the demons. This was a kind of warfare which they were not prepared for. They could not understand it. The deck was literally covered with tacks, and, being barefooted, the sharp little nails penetrated their feet, while with shrieks and yells of rage and pain they tumbled headlong into the sea, leaving the ship once more in the hands of her rightful owners. The natives, however, did not leave the ship without severely injuring at least one of the crew. While giving his order for the men in the top to scatter down the tacks the mate, Mr. Absalom Bunker, received a severe wound from an arrow just above one of his eyes, which necessitated his return to Nantucket and final retirement from the sea. He died in 1836. He was as capable and energetic a man as ever sailed from Nantucket, but this injury affected him mentally, and never after was he the same man he had formerly been. Mr. Bunker was grandson of Uriah Bunker, who, as previously stated, landed at Nantucket, April 19, 1775, the first load of oil from the Southern hemisphere. At the commencement of hostilities in 1812, England had many whale ships in the Pacific Ocean, most of them commanded by Nantucket men. A few, however, were in charge of Englishmen who had been taught the art of taking whales by Nantucket captains sailing from English ports. Later on in the war these ships, on sailing from England, were armed as privateers, and captured many of our own ships when full of oil and homeward bound. The gallant Porter, however, in the frigate Essex, made havoc among them, taking nearly the whole of the British fleet in the Pacific Ocean and running them off to Neuheva, Marquesas, where some were retaken and sent to England; among them the Seringapatam, Sir Andrew Hammond, Montezuma, and Greenwich. Among those remaining in our hands was the Atlantic, afterwards called the Essex, jr. She was a very fast ship, and was taken home by the late Commodore Downs (then first lieutenant of the Essex). When Commodore Porter ascertained that some of his captures were commanded by Americans he invited the captains into his cabin and treated them with courtesy and generosity.

The people of Martha's Vineyard were never a sea-going people in early times like their Nantucket neighbors. A few of her citizens came to Nantucket and sailed from here, becoming at once superior commanders, as well as fishermen. In 1816 old Capt. Jethro Daggett bought the New York ship Apollo, a small ship, 200 tons, carrying 1,700 barrels, and fitted her out for the Brazilian coast. This was the first enterprise of the kind on the Vineyard of which we have any knowledge. She proceeded on her voyage, but not meeting with success she was taken into Rio Janeiro and fitted for a more extended voyage to the Pacific Ocean and its extensive cruising grounds. In due time the ship returned to Edgartown full, with 1,500 or 1,600 barrels of sperm oil, and to this beginning were added many fine ships, not only to Edgartown but to Holmes Hole, and the island is now noted for its able captains and fine seaman, second to none in America.

Falmouth commenced with a new ship built in 1821, called the Pocahontas, 300 tons. She sailed for the Pacific in charge of F. B. Chase, of Nantucket, and filled with sperm-oil. A fine fleet of live-oak ships was built after this success, consisting of the Uncas, Hobomok, B. Gosnold, Commodore Norris, &c. Some of these ships were upwards of 400 tons and capable of carrying from 3,600 to 4,000 barrels of oil, commanded by other Nantucket men. Some of them are still engaged in whaling from other ports, for now not a ship sails from this port. The same story can be told of Wareham, Mattapoisett, Sippican, and other small places, not a ship belonging now to either of these ports.

Cape Cod is pretty well sustained by her bold Provincetown whale-fishermen. They have a small fleet of schooners, whose cruising ground is chiefly in the Atlantic Ocean, and they have done well in sustaining so large a fleet, considering the many trials they have met and overcome so nobly, both on the sea and on the land. The oil wells of Pennsylvania, war, bad voyages, Alabamas, disasters at sea—all have had their effect on the whale fishery in this and in all other places that have been engaged in this business since the disastrous days of the "California fever."

In 1830 Gloucester took the whaling fever, and the old Mount Wallaston was purchased of Mr. Crufts, a Russian merchant of Boston. The ship Louis was also purchased, and the commands of the two ships were given to Nantucket men. The venture proving unsuccessful, the ships were sold to New Bedford and Salem. Mr. Crufts at the same time sold his ship, with the apostolic name of St. Peter, to New Bedford. This gentleman was the contemporary of William Gray, the princely ship owner, better known as Billy Gray, and Benjamin Willis.

Although Mr. Gray's name has been mentioned in this article as being connected with the whale fishery in Boston, in the year 1820, it seems that about this time he offered all his ships then at sea, and to purchase more, if a certain enterprising citizen of Nantucket, personally known to him, would come to Boston, take charge of the fleet, and fit the ships for whalers. Believing that it would be the death-blow to the whaling interests of his native town, the citizen of Nantucket declined the proffered temptation.

Reading the annals of the Nantucket whale fishery, and looking back at the events that have occurred in connection with this gigantic business during the one hundred and seventy-five years of its history, calls up many well remembered scenes and traditions. Many and thrilling are the stories that can be told of incidents which have occurred under the frozen mountains of Disco and Greenland, on the burning coast of Africa and on Brazil, and on the more savage coasts of the Falkland Islands and Patagonia. And what a terrible loss of life and property has there been in the fearful encounters of our hardy seamen with that monster of the deep, the sperm whale. Of all the different species of whales, the spermaceti is the most savage when aroused.

Instances are on record where, as soon as struck by the harpoon, they have shown fight, and have attacked and crushed into kindling wood one, two, and even three boats in turn, crushing and mangling in their hugh jaws some poor fellow, or with one sweep of their monstrous tails sending whole boats crews to a watery grave.*

There are many living to-day who bear the marks upon their persons of wounds received in these terrible encounters. Some have lost limbs, teeth, had broken bones, and received contusions upon various parts of the body.

Even ships have been attacked by whales, as was the case with the Essex, Captain Pollard, in November, 1820. This ship was nearly full, and about to sail for home. One day, all the boats being off in pursuit of whales, a huge fellow was observed making for the ship, which he struck full on the bow, making her reel and tumble about like a shell. Making off to windward several miles, he turned, and made again for the ship with great speed, staving in her bow. She reeled over and sank to the water's edge. Of course the whole crew were obliged to take to the boats. Their sufferings were incredible, being obliged, in order to sustain life, to eat their own shipmates. Out of a crew of twenty men five only arrived home, three having been left at Dull's Island on the way to the coast of America. No other catastrophe upon the deep ever so touched the hearts of our people. There remains now but one survivor of this ill-fated crew, Capt. Thomas G. Nickerson, of Nantucket.†

Look, too, at the great number of our ships that have foundered at sea, or been wrecked on the coral beds near the equator, or upon the islands all over the Pacific, in some instances every soul on board perishing. And the men who carried on the whale fishery, commanded the ships, composed the crews; what of them? They were inured to every hardship known to sea life, and were heroes whom the world should acknowledge as such. Among them was Capt. Jared Gardner, half-brother to Jacob Barker, who was in command of John Jacob Astor's old tea-ship, then of Hudson, N. Y., in 1834, and who, on the day he was seventy years old, killed and took to his ship a 75-barrel sperm whale. James Josiah Coffin, in command of a ship from London, England, in 1826, killed and took to his ship, on the day he was seventy years old, an 80-barrel sperm whale.

John Paul Jones had five of our men with him on the Bon Homme Richard in the English Channel and North Sea. None were found more worthy to take a prize to France than Lieut. Reuben Chase, whom

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* When a whale has been found to be bent on mischief a cask is sometimes taken in one of the boats and, at the proper moment, thrown overboard. While the whale is venting his fury upon this bubble the boat is rowed quietly up to the monster, an officer takes the fatal lance and quickly and dexterously brings him to blood and death.

† The ships Union, Capt. Edward Gardner, 1807; Commerce, Capt. Jesse Bunker, 1813, and Ann Alexander, Captain Deblois, 1850, met similar fates.

Cooper has immortalized as "Long Tom Coffin," in his fascinating novel of the Pilot, a sea story that has charmed millions of readers.

It was not until 1849 that the matter was finally adjusted for carrying these prizes into French ports, the men or their families then receiving, through our Government, their share of the prize-money.

There is probably no town on the sea-coast of America that can point to so large a number of her citizens who have died in foreign ports, English, French, and Algeriene prisons. After the Revolution, returning to the town from the Jersey and Newport prison ships, some died in the harbor while in sight of their homes.

One hundred and ten years ago we had our London packets, some fifteen of which were commanded by the most experienced seamen of the place, and we sent to sea one hundred and thirty-five vessels on whaling voyages, which, together with the coasters and smaller craft, required upwards of twenty-two hundred seamen to man them.

The second light-house* in America was built on Brant Point in 1746 at the entrance to our harbor. It was lighted by the merchants of the town for upwards of forty-five years, when it passed under the control of the General Government.

The men of Nantucket were the pioneers and directors of the whale fishery for upwards of one hundred and seventy-five years. At this and every other port that followed it the record is a good one, and will stand forever. Other people having had at times a small degree of success, have claimed more than belonged to them, and would fain leave us in the wake of their recent beginnings. We ask nothing but what belongs to our place and people, and shall maintain at any cost our prerogative as pioneers.

There has been considerable discussion of late years as to who was the first person that struck and succeeded in killing and securing the first sperm whale ever captured in the Pacific Ocean. I have in my possession an authentic letter which gives credit to whom credit is due, and in order to set at rest forever this controversy the true facts of the case are here given. It seems that Samuel Enderly, a famous merchant of London, England, had been for some time in constant communication with the Rotches and others of Nantucket, purchasing of them many and large invoices of oil. Very naturally, he became much interested in the island, and fitted out from time to time many of our commanders for these undertakings in distant seas.

In 1788 Mr. Enderly sent to Brazil Banks the ship Aurelian, commanded by James Shields, who had for his first officer Archelus Hammond. Arriving on the whaling ground too late in the season, Mr. Hammond induced his captain to proceed around Cape Horn into the Pacific Ocean, which they reached in due time and commenced whaling. Mr. Hammond soon after *struck and killed the first spermaceti*

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*Brewster light was erected in Boston Harbor, 1715. *See* Drake's Antiquities of Boston, page 553.

whale. The ship was soon filled with oil and proceeded to Callao, Peru, to recruit, from whence she sailed for London, speaking on the voyage home, off Trinidad, lat. 20°, the ship Hope, Thaddeus Swain, forty-six days from Dunkirk, for Delago Bay, and arriving there in September, 1790.

Mr. Hammond proceeded to Dunkirk, France, and communicated to William Rotch the particulars of his voyage. The ships Falkland and Harmony were then equipped and ready for a voyage to Delago Bay, right whaling, but Mr. Hammond's story influenced Mr. Rotch so much that he decided to send the ships to the Pacific Ocean in pursuit of sperm whales. They were then taken into dock and coppered,* sailing respectively on the 12th and 20th of November, 1790, for their new destination, returning with full cargoes of sperm oil on the 7th and 14th of February, 1792; one having 1,200 and the other 1,600 barrels. Some of these facts were doubtless communicated to our people at Nantucket by Mr. Rotch, for in 1791 there were fitted out from here the Beaver, Paul Worth, Washington, George Bunker, Hector, Thomas Brock, new ships, and the Rebecca, Seth Folger, Warren, Robert Meaday, Favorite, and Obed Barnard, old ships, and all sailed for the Pacific Ocean.

In order that some idea may be formed of the proportions to which this great enterprise attained, attention is called to the following facts: In 1850 there were engaged in the whale fishery upwards of seven hundred ships, brigs, and schooners belonging to the United States, and in 1882, *not one hundred are left.* In 1843 167,000 barrels of sperm oil were imported, and in 1847 313,000 barrels of whale oil. These were the largest importations ever made. The greatest amount of sperm oil ever taken by a ship on any voyage was 4,181 barrels, and of whale oil 7,000 barrels, the first amount being secured by ship William Hamilton, of New Bedford, commanded by Capt. William Swain, of Nantucket, and belonging to Isaac Howland & Co.

The writer cannot conclude this article without giving some of the incidents connected with the fishery that was carried on from London, through the influence of William Rotch, in his many shipments of spermaceti oil from Nantucket to the merchants of that city, Messrs. Samuel Enderly, Thomas Dickerson, Barnard & Harrison, Chapman & Dickerson, and others, as appears from evidences in his possession. Shipments were made to London as early as 1720, and numerous well laden ships were sent from here between 1765 and 1800; at that date they obtained all the oils they required by their own importations direct from the South Seas. About this time a ship sailed from London, in charge of one of the Nantucket captains, for the east coast of the Cape of Good Hope and Madagascar, on a sealing and whaling voyage. When the

* Ships were coppered as a preventive against the encroachment of worms, and this was only done when the ships were sent into the Pacific on voyages of a year or more. In the shorter voyages the bottoms of the ships were tallowed, tarred, or painted.

ship had been absent from London eighteen months, receiving no news of her, and supposing her to be lost, the owners became discouraged and offered her for sale at "Doctor's Commons," the great mart in London for sales of prizes and for matters relating to commerce.

Mellish, the great London victualler, who supplied the Government with beef for the army and navy, hearing that the ship was to be sold, determined to purchase her, if some one would share the venture with him. He accordingly called on Mr. Bennett, a blacksmith, who had a shop near Wapping, and said to him, "Let's buy this venture." Bennett had by hard work and diligent industry saved a few thousand pounds, and immediately acceded to Mellish's proposition. "All right," said Mr. Bennett; the sum was fixed which they were willing to pay, and Mr. Mellish departed for Doctor's Commons. He soon returned and informed Mr. Bennett that they had become the successful purchasers of the supposed lost ship, the price paid being £1,000 ($5,000). In three weeks Mr. Mellish was back again in Bennett's shop, and commenced to banter upon his or their folly. "Are you sick of your bargain?" said the matter-of-fact mechanic, "and if so, what will you sell out for?" "I will sell for £400," Mellish replied. "I will take her," said Bennett. The papers were made, Bennett paid down his hard earned guineas, and the "venture" was his, Mr. Mellish going away this time from Mr. Bennett's shop a poorer man by some $500 than on his first visit. Three days after this transaction the missing ship anchored at Gravesend with a full cargo of oil, besides seventy thousand seal-skins, and Mr. Bennett, now famous and no longer obliged to earn his bread by the sweat of his brow, found himself enormously rich. All of this valuable cargo had been secured at the Crozette Islands, in the Indian Ocean.*

There were at this time in London two Nantucket men, Ransom Jones and Benjamin Swift, both men of superior endowments, who had just arrived from Delago Bay on a whaling voyage. The now renowned Mr. Bennett offered to each the command of a ship, and the offer being accepted he empowered them to purchase two Danish sloops of war then about to be sold at Doctor's Commons by the British Government. The ships were bought, and in due time sailed for Madagascar, the Crozettes, and Desolation Islands. Jones called his ship the Africa, and Swift named his the Brook Watson,† after a son-in law of Mr. Bennett.

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* A picture of this ship now hangs in the library of the Nantucket Atheneum.

† In 1833 Mr. Mellish was the owner of the ship Partridge when she arrived from the Pacific Ocean in command of Capt. Noah Pease Folger, a Nantucket man. The voyage had been a protracted and unsuccessful one, and was, of course, unsatisfactory to Mr. Mellish. He denounced Folger upon 'Change, which so irritated Folger that he procured a pistol and upon meeting Mellish fired at him, the ball cutting some of the hair from his head and making a slight scratch. Folger was arrested, tried, and sentenced to Newgate for life. An influence was brought to bear upon the King, William IV (who, as Duke of Clarence, when an admiral, had met on the ocean and in port many Nantucket captains), for a commutation of his (Folger's) sentence. The

In thirteen months the Africa returned to London with 7,000 *barrels sperm whale and seal oil, and* 70,000 *seal skins.* The Brook Watson went into Delago Bay, where Captain Swift was taken sick with the African fever, died, and was buried; but he did not die alone. In the bay at the time were the ships Cyrus, Archelus Hammond (before mentioned), Dolphin, Stephen West, and Paul West, and a host of kindly and brave men performed the last sad rites for their fellow townsman, under the burning tropical sun, in a strange and far-away country. The mate of the Brook Watson took charge of her, sailing from Delago Bay to the east of Cape of Good Hope, where he obtained 1,300 barrels of oil, arriving safely in London, making, with this addition, Mr. Bennett *the richest commoner in England.* He subsequently fitted out a great many whalers, and there have been seen at one time (1824) at the Sandwich Islands twenty of these ships, among which may be mentioned the Royal George, Recovery, Daniel 4th, Lady Amherst, &c.

The *first ship* that ever entered the harbor of Nantucket was the Neptune, October 30, 1765, a London packet commanded by Nathan Coffin, previously mentioned. On her first voyage out she took from Nantucket a load of sperm oil, consigned to Barnard & Harrison, of London. Previous to this date we had only brigs, schooners, and sloops, and after 1765 nearly all of these brigs were rigged into ships.

The ship Barclay, which Mr. William Rotch had ordered to be built while he was in France in 1793, sailed from London in 1795, in command of David Swain, of Nantucket, bringing Mr. Rotch as passenger to Boston, where she arrived after a stormy passage of sixty days. October 23, 1799, the Barclay, under command of Griffin Barney, of Nantucket, sailed from New Bedford for the coast of Chili on a sealing voyage. She filled with skins off St. Felix, and proceeded to Canton, China, where she disposed of the skins, and returned to New Bedford with a rich cargo. She was engaged in sperm whaling in the Pacific Ocean for many years, after this always obtaining valuable cargoes. In 1814 she was captured by the Spaniards, who nearly succeeded in taking her into Callao, when the late gallant Commodore David Porter, of the frigate Essex, recaptured her, cutting her out from under the guns of the fortifications of that fort, and restoring her to Captain Randall, who was in command when she was captured. She arrived safely in New Bedford full of sperm oil. She was finally broken up at New Bedford in 1864.

When our ships first appeared off the coast of Peru, in the latter part of the last century, the Spanish Government, learning the object of their

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King was prevailed upon to pardon Folger on condition that he leave England forever, which he agreed to, and returned to Nantucket, where he died December 7, 1837.

The Partridge was a sister ship to La Eagle, captured from the Danes at Copenhagen in 1807. In 1824 La Eagle, in command of Capt. Valentine Starbuck, another Nantucket man, took as passengers to London the king and queen of the Sandwich Islands, both of whom died in London of the measels. Captain Folger was a nephew of Noah Pease, who for many years was a resident of London, and a successful shipmaster out of that port, in the South Seawhaling.

visit, immediately dispatched two frigates from Spain to prevent their whaling around the shores or near the coast of Chili or Peru. Several captures were made and carried into port as lawful prizes, among which was the Beaver,* Paul Worth, of Nantucket.

After some detention and a great deal of negotiation she was released and arrived home in 1793, with a full cargo of sperm oil.

I must not forget to relate that in one of the interviews William Rotch had with George III, Pitt, and Lord Hawkesbury, upon the fishing privileges, and in which Mr. Rotch strongly urged the admission of twenty ships from Nantucket, with all their outfits, free of duty, the King demanded of Rotch what equivalent he expected to give if he was granted all the boons he asked for: "*I am going to give thy Majesty the young men from my native isle,*" was the answer received by his Imperial Highness from the sturdy old Quaker republican, and sure enough, in time, London saw a host of them.

One more fact and I am done. The first ship to cross the equator to the southern hemisphere was the Amazon, commanded by Capt. Uriah Bunker, who obtained a full ship, and anchored at Nantucket bar *April* 19, 1775, *the day on which the battle of Lexington was fought.*.

These notes are not given with the idea that they make a complete history of the whale fishery. A hundred volumes could be written and a hundred writers might spend their lives in weaving the halo of romance about these ships and their commanders, and make stories to which those of the Pilot, the Phantom ship, and Sinbad the Sailor are as children's prattle. Then the half would not have been told of this gigantic undertaking, which required so much capital, so much skill and daring, which sent ships into every sea, even into the ends of the earth, ships manned by a set of heroes who braved every danger and suffered every hardship. These notes are given here as simple facts, in order to rescue them from that oblivion and forgetfulness to which they might else be consigned, and for the benefit of those who take an interest in the noble men who go down to the sea in ships.

JANUARY 16, 1883.

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*This ship was the namesake of the one which assisted in making the brew of fragrant bohea, whose fumes wafted across, the Atlantic, set the nerves of all Europe a tingle, as well as our own, only, however, by putting it overboard.

IX.—THE BOTTLE-NOSE WHALE FISHERY IN THE NORTH ATLANTIC OCEAN.*

By Thomas Southwell, F. Z. S.

In the early days of the whale fishery, when the Arctic right whales which frequented the seas off the coast of Spitzbergen, or Greenland, as it was then called, were so plentiful and easy of approach that they only required to be killed, there was very little skill in whaling, and the whalemen of those pleasant times doubtless regarded with contempt the smaller Cetaceans which so often now go to make up a cargo. In 1697, one hundred and eighty-eight vessels killed one thousand nine hundred and fifty-nine whales, and as the "fish" were at that time found close to the shore, the practice was to land the blubber and try it out on the island, carriers being employed to take home the oil that the vessels might not be delayed in their profitable occupation.

This happy state of things of course did not long continue; the whales were soon all killed or scared away, and had to be followed farther afield and more skillfully approached; a like process of exhaustion subsequently brought to a close the shore fishery from the west coast of Greenland, where the whales were killed from the shore as they passed the Danish settlements on their northward migration in the spring. There is no reason to believe that the Greenland right whale ever occurred much farther south than our early whalemen found it, and its disappearance from some of its former localities and greater scarcity in its present habitats is probably due to actual extermination, and perhaps in some degree to timidity induced by unremitted persecution, more particularly since the introduction of steam. In the palmy days of the fishery from Peterhead twenty or thirty whales was no uncommon result for one vessel, and in 1814 seven vessels brought home one hundred and sixty-three whales, Captain Suttart, of the Resolution, leading the list with forty-four fish. This, it must be remembered, was before the introduction of steam, the advantage of which in ice navigation is incalculable. The years 1830 and 1831 were exceedingly unproductive, so much so that in those two seasons sixteen vessels killed only forty-eight whales, yielding 548 tons of oil, notwithstanding which in the thirteen years, 1821 to 1833, inclusive, one hundred and fifteen voyages by sailing vessels from the port of Peterhead to Davis Straits, produced 12,862 tons of whale oil, equal to 112 tons per voyage, and

* The bottle-nose whale, *Hyperoödon rostratus*, having several times of late been captured on the Atlantic coast of the United States, the following observations by Mr. Southall are of much interest.

averaged eleven fish each; whereas in the thirteen years, 1870 to 1882, with all the advantages derived from the use of steam, one hundred and ninety-six voyages produced only 13,670 tons of oil, or an average of 69½ tons from seven and one-quarter fish per voyage. In 1880 the average was about eight whales per ship; in 1881, five whales; in 1882, it rose to nearly nine, and in 1883 it was not quite three fish per vessel.

The consequence of this falling off in the productiveness of the Right-Whale fishery is that the whalemen give their attention to much smaller game than formerly and do not disdain to capture White Whales to help to fill up; during the past season (1883) the Dundee vessels have brought home no less than 2,736 of these creatures, which are by no means to be despised as, in addition to their oil, the recent demand for "porpoise" hide makes these skins a valuable cargo.

Of late, however, quite a new feature has sprung up in the whale-fishery. I allude to the pursuit of the Bottle-nose Whale (*Hyperoödon rostratus*). The whalers have long been in the habit of taking an occasional Bottle-nose, and many years ago the Chieftain, of Kirkcaldy, caught 28 of them off Frobisher Strait, but it was not till the year 1877, when the Jan Mayem, then of Peterhead, having missed the seals, succeeded in taking 10 Bottle-noses, that their pursuit attracted much attention. Since that time, however, they have been more sought for, and most of the smaller vessels now hunt them every season, whilst some of the largest ships, in the interval between the finish of the seal-fishery and the commencement of the whaling, go south to the northeast coast of Iceland for the same purpose. In 1878 there were 9 killed; in 1879, 8; in 1880, Capt. D. Gray, of the Eclipse, commenced to give his attention to the pursuit and killed 32; in 1881, 111 were killed, of which 39 fell to Captain Gray, and but that his crew were new to the work he might have obtained a still larger number. This was proven in 1882, when out of 403 Bottle-noses killed by the Scotch fleet, Captain Gray secured 203. In the past season (1883), 535 have been killed by eleven vessels, Captain Gray again taking the lead with 157 fish.

Soon after leaving the Shetland Isles, early in the month of March, northward bound sealers meet with the first Bottle-nose Whales, and as the season advances they extend their range northward to the coast of Greenland, ascending in a westerly direction Davis Straits as far as 70 north latitude wherever there is open water, and to the eastward of Greenland from Cape Farewell round Iceland and Jan Mayen northward to 77° and eastward to Bear Island, and probably to Novaya Zemlya. They appear, however, most to abound between the 68th and 71st parallels of north latitude (gradually approaching the higher latitude as the season advances) and from 15 degrees west to 5 degrees east longitude.

Here they frequent the open water near the margin of the ice, swimming in small "schools" of from 4 to 10, numerous schools often swimming in close proximity, but apparently never mingling. The females and

young males are generally associated, with often an old "bull" as a leader, but as a rule the latter generally keep apart. In this respect, as in many others, their habits greatly resemble those of the Sperm Whale of the South Pacific. When swimming undisturbed along the surface of the sea the body is at first submerged with the exception of the anterior portion of the head. Gradually, however, the body emerges as far as the dorsal fin, and after swimming thus for a short distance the speed slackens and the creature prepares to descend by allowing ing the head to sink, the back is elevated, displaying above water an exact segment of a circle. It then deliberately descends, seldom showing its tail unless excited. When alarmed or angry, however, it thrashes the sea violently with its tail and sometimes leaps bodily out of the water. On one of their number being harpooned the remaining members of the school refuse to desert it whilst it is alive and thus frequently fall victims to their solicitude; this is occasionally not confined to the herd of which the struck whale is a member, for Captain Gray tells me they will come from every point of the compass towards the fast whale in the most mysterious manner. They are very difficult to kill, and when wounded dangerous to approach. Captain Gray has known them to run out 700 fathoms of line and to remain under water for two hours. The food of this species appears to consist almost entirely of spmbs (*loligo*).

All the above might with very slight modification have been written of the southern Sperm Whale, but the curious similarity does not cease here, for the commercial products of the Bottle-nose Whales are almost identical with those of the former; its head contains similar "matter" and the oil, of which the full-grown animal yields about a ton, is little, if any inferior, to true sperm oil, its market value being about £60 per ton of 252 gallons. The following table gives the results yielded by the analysis of a sample of Bottle-nose oil compared with those of a similar sample of Pacific sperm oil.

PUBLIC ANALYST'S LABORATORY, No. 1,
Surry Street, Sheffield, August, 1882.

Report on a sample of oil from the blubber of the Bottle-nosed Whale received from William Baxter, esq., 20 *Harbour street, Peterhead, N. B., on August* 11, 1882.

The following are the results yielded by the sample and by a specimen of genuine sperm oil analyzed for comparison:

	Bottled-nosed Whale oil.	Sperm Whale oil.
Specific gravity at 15.5° C	.8763	.8778
Flashing point ° C	264	260
Viscosity (seconds)	141	137
Unsaponifiable matter (spermyl alcohol)	39 76	40 50
Specific gravity of unsaponifiable matter	.8363	.8307
Rise of temperature with sulphuric acid ° C	41	45
Color reaction with sulphuric acid	Pale brown, changing on stirring to light violet, and again to brown.	Dark brown, becoming some darker, with tinge of violet on stirring.

These results show that the closest similarity exists between genuine sperm-oil and the oil from the Bottle-nosed Whale. They are peculiar among fish oils for their low density and viscosity, and are distinguished from all other oils by their chemical composition, which is more allied to that of spermaceti and the waxes than to ordinary oils.

When properly refined, I have no doubt the oil from the Bottled-nosed Whale will be found suitable for all the applications of sperm oil, and for some purposes it could be used in the raw state. I see no reason why it should be considered in any way inferior to sperm oil.

ALFRED H. ALLEN, F. I. C., F. C. S.,
Lecture on Chemistry at Sheffield School, Medicine, &c.,
Public Analysis for the West Riding of Yorkshire, &c.

In form this species is even more singular than the Sperm Whale. Until described by Capt. David Gray, the adult male was absolutely unknown in the flesh and so different in form and proportion was its skull from that of the well-known female and young male of the same species that from the evidence of the skull alone Dr. J. E. Gray was led to establish not only a new species, but also a distinct genus, (*Lagenocetus laterostris*). In the flesh the head is abruptly truncated and almost quadrangular in shape, having been not inaptly likened to the end of a portmanteau with rounded angles. By the whalers they are appropriately known as "Flat-heads." From the head to the dorsal fin, which is situated about two-thirds of the distance from the head, the body decreases very little in diameter, but the remaining third, rapidly diminishes in size until the tail is reached. The flukes of the caudal fin, instead of having a medial notch, are entirely along the margin and nearly straight. The front of the inferior surface of the head extends beyond the junction of the the upper surface of the "beak" so as to produce a hollow notch, like what is known as a "beetling" brow; the flippers are small and placed just behind the eye. In the females and young males the form is more slender and the head rounded; the latter, however, gradually assume the flattened form of head as they approach maturity, but in the female no such change takes place. The females as well as the young males are black, but with age the hue of the males become lighter until in very old individuals it assumes a yellowish tinge, the back and front of the head and neighborhood of the eye being quite white. The belly is always grayish white.

They are usually greatly infested with parasite, a sessile-eyed crustacean belonging to the order *Amphipoda*, known as *Cyamus Thompsoni*. Of 203 of these Cetaceans killed by Captain Gray in 1882 the proportions of ages and sexes were as follows: old males, "flat-heads," 96; "cows," 56; and young males, 51.

At the approach of winter the Bottle-noses retire from the Arctic seas, and passing south resume their solitary wanderings. From the fact of those which have occurred on the British coast having been invariably females and young males, it seems probable that the old males adopt a different line of migration.

For the following description of the mode of capture and subsequent disposal of the Bottle-nose Whale I am indebted to Capt. David Gray, of the S. S. Eclipse, of Peterhead, by whom this new industry has been mainly developed and most successfully prosecuted:

In fishing for Bottle-nose Whales the arrangements are much the same as those adopted for the pursuit of the Greenland Whale; the crew are divided into three watches, each watch mans two boats, and if necessity requires it a seventh boat is manned by the odd hands of the different watches. It requires one harpooner, one boat-steerer, and four oarsmen to man each boat, and the custom is when a whale is seen, for the watch on deck to man two boats and lower away; if either of them should get fast a "fall" is called and all hands immediately turn out and are ready to man the other boats if required. When a boat gets fast the nearest boat to the fast one at once pulls up and bends the end of his whale line on to the end of the fast boat's lines, the other boats pull ahead of the fast boat and await the whale coming up to breathe, and it is then the duty of the nearest boat to pull up and strike in a hand harpoon and kill the whale; the other boats then are free to get fast in a loose whale should opportunity offer.

Each boat carries three whale-lines, each 120 fathoms long, and they are carefully coiled into the stern, about 8 fathoms of the lower end being left out, which is called the "stray-line," and is required for another boat to bend on to. The upper end of the whale-line is brought forward along the center of the boat and is passed through a notch in the boat's bow called a "sheer-cleat." This is required to prevent the lines from running over the boat's side and thereby endangering a capsize. The whale-line is then bent on to a rope about 10 fathoms long called the "fore-goer," which is coiled into a tub in the boat's bow, and when the harpoon is attached to the fore-goer and rammed home in the gun the whole apparatus is ready for use.

Immediately upon getting fast in a whale the harpooner holding the whale-line in his hand takes three or more turns with it round a strong piece of wood in the boat's bow called the "billet-head" and allows it to run through his hands. The boat-steerer and line manager are at the same time employed in watching the lines and seeing that they do not foul. If the lines should happen to foul the boat-steerer at once calls out to the harpooner "foul lines," and he immediately takes the turns of the whale-line off the billet-head and lifting the line out of the sheer-clete allows the lines to run over the bow till they are clear. If the harpooner should hesitate in taking off his turns from the billet-head and in lifting the lines out of the sheer-clete there is great danger of their becoming jammed and the whale taking the boat down.

A whale-boat also carries one hand harpoon and two lances, the hand harpoon is on the American principle, a "toggle-iron," and the lances are about 6 feet long, of which the stock is 2 feet and the spear is 4 feet.

When the whale is exhausted the boat endeavors to come to close quarters for the purpose of administering the *coup de grâce* with the lance, for which purpose the harpooner endeavors to haul the boat right over the whale's back. A Bottle-nose Whale cannot go away without making "aback," that is, by lowering his head and arching his back, bringing the leverage of his tail to bear; so long therefore as the boat is able to keep the whale's head up, his tail, the organ of locomotion, hangs powerless, or almost so, beneath the boat's bottom and the animal, in spite of its violent efforts to free itself, is soon dispatched.

When the dead whale is brought alongside the operation of flensing commences. This is performed as follows: A rope is thrown from the ship and a running loop put over the whale's tail. Four harpooners then enter a boat and one of them cuts a hole in the head and a rope is run through, by means of which the steam winch heaves the whale up and down. The harpooners then cut the head half off, and after cutting another hole in the blubber behind the shoulder and reeving a rope through, the head is cut off altogether and hoisted on board. After the head is on board the tail is hauled up to the surface, bringing the whale into a horizontal position, and the main-speck is hooked on to the hole cut behind the shoulder. The harpooners then make a cut along the body to within 4 feet of the tail, where a cross cut is made through the blubber. At the end of the fore-and-aft cut a second hole is made and a rope is hove through it to which the fore-speck is attached. The harpooners then commence to separate the blubber from the body, the steam winch at the same time heaving on the main, and the capstan on the fore-speck. The body-slip is thus gradually separated from the body, being half torn by the steady strain of the two specks, the harpooners at the same time cutting with their spades the sinues and muscles which bind the blubber to the body. The "body-slip," when clear off the carcass, is hoisted on board and spread out on the deck with the skin side up. The tail and rump are then separated from the body and also hoisted on board. The body itself thus turned out of the blanket of fat, with which it was invested, is allowed to sink into the sea. The crew then scrape the skin off the body-slip and cut the blubber into square pieces which are put below for the present to be "made off" in the usual manner when opportunity offers. The head is also scraped and the blubber cut off. The oil, too, is extracted from the jaws, after which it is thrown overboard. The tail is reserved to serve as chopping blocks in the subsequent process of "making off," which need not be described here. Last of all the hose is rigged, and when the highly necessary operation of deck washing is concluded, the crew are again ready to man their boats for a fresh capture. When the crew are in working order and every man has come to know his place, the whole process of flensing, from the time the whale is brought alongside until the decks are washed down and the ship clear, does not occupy more than fifteen minutes.

It remains to be seen whether this new industry will be judiciously followed or whether so profitable a field of enterprise will be speedily ruined by overfishing. From the number of vessels which are reported to be equipping for next season's voyage, it is to be feared that the latter will be the case; or, that the whales, rendered timid by constant persecution, will learn to take care of themselves, of which, even now, there are indications. One indirect benefit which may possibly arise from this diversion of the whaling energy into a new channel is that the Davis Straits fishery for Right Whales, which has of late years been sadly overdone, may be allowed a short respite. Otherwise it seems likely that the present excessively high price of whalebone might lead to so eager a pursuit of these valuable Cetaceans that their extermination would be speedily accomplished.

NORWICH, *December*, 1883.

X.—EXTRACTS FROM THE FIRST ANNUAL REPORT OF THE FISHERY BOARD OF SCOTLAND FOR THE YEAR ENDING DECEMBER 31, 1882.

A.—SCIENTIFIC INVESTIGATIONS PROPOSED BY THE FISHERY BOARD OF SCOTLAND, AS NECESSARY FOR THE IMPROVEMENT OF THE FISHERIES.

Taking into consideration that the Board is not only required to make suggestions for the improvement of the fisheries, but is empowered to "take such measures for their improvement as the funds under their administration, and not otherwise appropriated, may admit of," and taking into consideration also the important practical results obtained by the United States Commission of Fish and Fisheries, we decided, as soon as provided with the necessary appliances, to institute investigations into the habits and life history of some of our more important food-fishes, such as the herring, cod, ling, haddock, mackerel, sole, plaice, and flounder.

The following questions we consider as deserving of careful investigations:

1. The food, life history, distribution, and migration of useful fishes.
2. The nature of the feeding and spawning grounds of food-fishes.
3. The period of spawning, nature of the ova, and the time required for and the conditions favorable to hatching.
4. What means can be adopted for the protection of fish during their early stages of growth, and what can be done to prevent the destruction of immature fish.
5. What new useful fishes (such as the American shad and the land-locked salmon) can be introduced, and how far the supply of our present forms can be increased by artificial cultivation or protection during the spawning period.
6. The influence of atmospheric variations and of the changes of the temperature of the water and of currents on the presence and migrations of fish, and the nature and depth of the water where fish commonly abound.
7. The special enemies of useful fishes, and the causes of the disappearance of fish from certain districts.

We further believe that it is desirable to make a collection of useful fishes and their food.

Recent investigations indicate that out of every million of ova of cod

and other sea fish only very few undergo development, and that only a very small number of those developed ever reach maturity. This being the case, it will be evident that if the eggs are placed in circumstances favorable to development, and if the young are protected for some time after hatching, the number of any given fish might be increased to an almost indefinite extent. Hence it might have been expected that we would first have directed our attention to the artificial cultivation of the cod or some other fish that appears rather to be diminishing than increasing in numbers along our shores. This, however, necessitates more appliances than we can at present command, and we have therefore determined to begin our inquiries by endeavoring to increase our limited knowledge of the herring, especially of its food and early life-history. That this is not only an important question to take up, but one of the first questions which deserves attention, will be evident when the part the herring plays as food, not only for man, but also for the cod and salmon, is taken into consideration.

In order to carry on investigations as to the food, habits, and early life-history of the herring, it was necessary to have at our disposal a steam-vessel, dredging apparatus, &c. Accordingly we applied to you to move the Lords of the Admiralty to grant the use of a steam-pinnace. This application has for the present been declined, for reasons stated; but, as you are aware, we are still in communication on the subject, and it is to be hoped that the Lords of the Admiralty will yet see their way to grant our request; for, if the investigations could be set on foot at once, we are confident that important results could be obtained during the remaining part of the present year.

In reference to the above proposed scientific investigations, we are impressed with the importance of testing new and more skillful methods of fishing, as, for instance, the successful working of the seine purse-net upon the American coast, which might probably be well adapted to the herring fishery on our own coasts; also the cod gill-net, likewise used with much success on the American coast; and there is no doubt that, with increased Government assistance, much might be done in this direction for the development and improvement of our fisheries.

B.—THE EFFECT OF FIXED ENGINES ON THE SALMON FISHERIES—A PRIZE ESSAY ON "SALMON LEGISLATION IN SCOTLAND," BY J. M. LEITH.

We now come to "fixed engines," which, together with pollutions, share the unenviable distinction of being the most destructive agency affecting the salmon-fishings of the whole kingdom. It was very early discovered that the use of fixed nets and engines in rivers exercised an injurious effect upon the development of the fisheries, and in fact that it promised, if unrestricted, to exterminate salmon altogether. Therefore, as we see by the old statutes before referred to, fixed engines were

sternly and forcibly prohibited both in rivers and estuaries, and this prohibition has been confirmed by modern judicial decision, and also by statute, except with regard to a certain limited number of cruives and yairs, which exist by virtue of special grant from the Crown, and cannot be abolished without compensation. About sixty years ago, however, it was discovered that nets fixed on sea-shore were quite as productive as they had been in the rivers, and accordingly in a comparatively short period the whole coast bristled with them, altogether irrespective of right to fish for salmon. They have somewhat decreased since then, because in many cases it was found unprofitable to work them; but they still exist in large numbers, and, judging from the weight of evidence and authority which is accessible on the point, they are prejudicial to the increase and preservation of salmon, and, if they cannot be altogether abolished, they should be placed under much more stringent regulations. It is urged on their behalf (1) that they are established by prescription, and cannot, therefore, be abolished without compensation; (2) that to abolish them would seriously affect the food supply of the country from this source; (3) that though they may diminish the number of fish which reach the rivers, they cause no decline in the total number of fish caught annually; and further, that the fish which they catch are in better condition than those in the rivers; and (4) that no other method of fishing with profit is available in the sea. The first of these pleas is a very plausible one, and no doubt will be very difficult to get over. Prescription, however, cannot run against statute; and though fixed nets on the shore are not specifically mentioned in the old statutes, we ought to hold them included, because the spirit of the whole legislation is so clearly and forcibly directed against that mode of fishing as being unfair and destructive that we cannot doubt that the prohibitions would have been extended to the sea had fixed nets been in existence there at the time. Remedial statutes must receive a liberal interpretation. These old acts prohibit all fixed engines in the "run of the fish." The natural history and habits of the salmon were not then well known, and the legislators were totally ignorant of the fact that the sea-shore was as much the "run of the fish" as the river. In no charter granted is any such mode of fishing authorized or contemplated, and the proprietors of fixed nets have simply erected them without any right to do so and on chance of no one interfering. It was in the rivers that salmon fishing was originally recognized as property, long before even a coast charter was granted (in 1603), and no person had at any subsequent time a right to encroach on this private property. That is exactly what the fixed-net fishers on the coast have done, however, with the result that what was once a valuable possession has in many cases become useless, and no compensation has ever been paid to those deprived of a considerable portion of their income, in securing which often a large amount of capital had been sunk. It is difficult to see what better claims to compensation those persons would have for

the abolition of a practice which was really illegal at first, and which has only acquired a semblance of right because, owing to the uncertainty of the law and the want of proper opposition, it has been allowed to exist beyond the prescriptive period. The appropriation of the waters of rivers and streams by manufacturers, without any title, and totally oblivious of the rights of others, is a case on all-fours with that under discussion. Their doing so destroyed in many cases the fishings enjoyed by riparian proprietors, and deteriorated in all cases the value of the land through which the streams passed; but for want of proper challenge, and a notion that it would not do to interfere with industry, the illegal encroachments were allowed to go on till they obtained a hold which it is difficult now to shake off. The dispossessed proprietors had no compensation here either. No doubt many of the present proprietors of coast fisheries have paid large sums for their fishings in the belief that they were legal, and it might be hard to punish them for the fault of their predecessors. These cases might, perhaps, receive extra consideration, but they do not affect the public question of the legality or illegality of the fixed nets; and if that question were decided against the legality, there can be no doubt that there would be no right to compensation. On the contrary, there would arise claims of damages on the part of those who had suffered from the usurpation.

There is a strong preponderence of evidence and presumption that these nets were unlawfully erected at first against the spirit, if not the letter, of the statutes, and that therefore prescription should not be held to legalize them. Besides, prescription properly only applies to private rights, and has never been, and is not now, admitted where it is "hurtful to the commoun weill."

The argument that the abolition of fixed nets would seriously reduce the food supply of the country, supported, as it is, by the high authority of the commissioners of 1870, is, of course, entitled to greater consideration. But it is fair to state that there is a good deal of evidence on the other side, and it is backed up in many cases by actual proof. A useful pamphlet, published by Mr. Alexander Jopp, in 1860, contains a large quantity of valuable statistics relating to the Aberdeenshire fishings bearing upon this point. It is shown conclusively that salmon had greatly decreased, both in number and weight, since the introduction of stake-nets, though of course his results referred more particularly to the rivers and not to the sea. But the number of boxes of salmon exported tells the same tale, and a stronger proof still that the total number of fish is diminished by stake-nets is derived from the fact that several proprietors of fixed nets on the coast obtained a large increase of the rentals of their whole fisheries by giving up these fixed nets. The Duke of Richmond, for example, increased his rental from £6,000 to £13,000 in eight years by removing his fixtures at the mouth of the Spey, and the Duke of Sutherland and Earl of Fife, by adopting a similar policy, attained similar results. There are proofs of the same kind

in connection with the fishings on the Solway and elsewhere. Not only, therefore, do fixed engines diminish the number of fish which reach the rivers, but they diminish the total annual number of fish caught, and the statistics of the present day bear out, on the average, those just referred to in this conclusion, though of course there are also other causes at work, and considerable fluctuations. It is undoubtedly the case that fish taken in the sea are in superior condition to those caught in fresh water, but of what avail is that if we take them in such numbers that there will soon be no more left to be caught? In some places on the coast no other mode of fishing is properly available except fixed nets, but the same may be said of the rivers, and yet fixed engines have been abolished there without compensation. The assertion that no other mode can be followed with profit is subject to qualification—it should be with so much profit—seeing that the capital is also encroached upon to a greater or less degree. Besides, from the point of view of the public interest, these stake and bag nets are objectionable on account of the expense involved in working them, which considerably increases the price of the fish to the buyers. I have seen various estimates of the difference of cost of working stake-nets and net and coble, and it is in all cases very marked.

Many exhaustive inquiries have been instituted by Parliament on this subject, and the almost invariable result has been that commissions and committees have recommended that fixed engines should be entirely suppressed, and accordingly suppressed they have been in England, and in Ireland at least checked and strictly regulated. But if it should be deemed inadvisable to put them down altogether in Scotland, they can and ought at least to be placed under strict regulations, and adequate measures taken to insure that these regulations are carried out to the letter, and in this view the suggestions contained in the Special Commissioners' Report of 1871 are admirable and should be adopted. The distance from the mouths of rivers, however, recommended by the commissioners, might, with advantage, be extended in most cases to from 1 mile to 3 miles, according to the configuration of the coast; stake-nets should in no case be allowed to extend further than from high to low water mark, and bag-nets, in addition to being restricted to steep, rocky coasts, and not allowed to be joined to stake-nets, should not be permitted within 3 miles of the mouth of any river. This is the law in Ireland as to stake and bag nets. Very severe penalties should be enacted for breach of weekly or annual close-time, as there is reason to believe that in many cases at present the law is simply ignored, and if any complaint is made, stress of weather or absence of employés is pleaded. It has been suggested that in any case where stress of weather prevents the due observance of the weekly close-time, the owners or tacksmen of the nets should be bound to report the matter to the chief constable of the county, or other official, and satisfy him that the nets were closed for fishing for an equal period when the weather allowed it;

also that the close-time should be by tides, and not by hours, as is already the case in the Tweed.

With regard to reducing the number of fixed engines now plying, a great deal of power rests with the Crown as owner of all the fishings on the sea-shore ungranted, and surely the public are entitled to look to the Crown to exercise that power. (1) If the Crown were to carry to its legitimate issue the inquiry set on foot in 1859 as to the titles of all persons exercising fishing on the sea-shore, a large number of persons now fishing without a title would be turned off. (2) Every proprietor whose title had been examined and found satisfactory should be entered on a register (a copy of which should be supplied to district boards), and a certificate to that effect should be granted him by the Commissioners of Woods and Forests, which he should be bound to exhibit at all times when asked by proper authority, care being taken, of course, to provide that this was only a certificate of title, and not of legality of any mode of fishing. (3) After a reasonable interval to allow proprietors to send in their titles for examination, it should be declared that all persons not in this register, and not provided with certificates of title, should be liable to prosecution and penalties for illegal fishing, which should be rigorously enforced. Any proprietor producing a good title after prosecution instituted to be liable in all expenses. (4) In all the fishings which would thus lapse to the Crown, and all those presently in its possession, let or unlet, the Crown might be expected to forego making profit at the expense of the public good, and prohibit the use of fixed nets to all its lessees. If these suggestions were carried out, the number of fixed nets would be greatly reduced, and it would then become much easier to make regulations regarding the number of nets to be allowed on a certain expanse of shore, distance from rivers, &c.

C.—THE HERRING, COD, AND LING FISHERIES OF 1882.

1. THE HERRING FISHERY.

The herring fishery of 1882 was, with the single exception of that of 1880, the largest upon record. In 1882 the total number of barrels cured was 1,282,973½, while the number cured in 1880 amounted to 1,473,600¼.

The particulars of the results of the fishing of last year, when compared with those of 1881, show a considerable increase in the herrings cured and exported, but a decrease in those branded and in the amount received for brand fees. The returns are:

Years.	Barrels cured.	Barrels exported.	Barrels branded.
1881	1,111,155¼	745,879¾	494,182½
1882	1,282,973½	825,982¾	462,612½
Increase in 1882	171,818¼	80,103	....
Decrease in 1882	....	....	31,570

If the results of 1882 are compared with the average of those of the ten previous years it will be seen that they show a large increase in all the items. The particulars are as follows :

Years.	Barrels cured.	Barrels exported.	Barrels branded.
Average of ten years, 1872–'81	943, 487	650, 895	453, 262
1882	1, 282, 973½	825, 982¾	462, 612½
Increase in 1882	339, 486½	175, 087¾	9, 350½

2. THE COD AND LING FISHERY.

The cod and ling fishery of 1882 yielded an increase of 5,823½ cwts., cured dried, and 3,661½ barrels cured in pickle, over the fishing of 1881. There was an increase in the quantity cured on shore, amounting to 19,200½ cwts., and to it nearly all the districts contributed; but this was so largely counterbalanced by a decrease in the quantity cured on board of vessels that the net increase only amounted to what is stated above.

In Orkney district, at the end of January, when herring bait could be got, the cod and ling fishing was very successful, and the small native boats were frequently loaded. In Stornoway district the weather was unfavorable till the end of March, but it moderated in April and May, when excellent fishing was had. In Shetland district strong winds retarded the spring cod-fishing till May. Thereafter the weather became more settled, and the boats succeeded in making fair average catches. Two hundred and twenty-seven decked boats were engaged in the fishing, of which 150 belonged to Shetland, and the remaining 77 to other districts on the east coast. The quantity of ling caught in Shetland during the season was fully equal to the average of recent years; and in the cod and ling fishing, as in the herring fishing, the six-oared open boats, which were formerly so much in use, are gradually being superseded by large decked boats.

A result of the success of the spring cod and summer herring fishing in Shetland has been that the fishermen there now prefer to purchase shares in decked boats and fish at home instead of manning vessels for cod-fishing on the coast and at Faroe and Iceland. In consequence of this only 19 vessels were fitted out in 1882 for Faroe and Iceland, and there was difficulty in getting fishermen to man even this small number, whereas a few years ago 38 vessels were sent to fish at these places. The vessels got a fair amount of success at Faroe, but on afterwards proceeding to Iceland in August they were met by large quantities of floating ice, so that their fishing was much obstructed and proved a poor one. The decrease in the quantity of fish cured on board of vessels in 1882, as compared with 1881, was 13,437 cwts.

The total quantities of cod, ling, and hake cured and exported in 1881 and 1882, respectively, are:

Total quantities of cod, ling, and hake.

Years.	Cured.		Exported all-cured dried.			
	Dried.	In pickle.	To Ireland.	To the continent.	To places out of Europe.	Total.
	Cwts.	*Barrels.*	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*
1881	115, 513½	4, 075½	27, 809	26, 870	6, 747	61, 426
1882	121, 337	7, 737	23, 846	23, 326	9, 325	56, 497
Increase in 1882	5, 823½	3, 661½			2, 578	
Decrease in 1882			3, 963	3, 544		4, 929

3. FISHING BOATS.

The following table shows the number of boats, decked or undecked, employed in the shore-curing herring and cod and ling fisheries, Scotland; the number of fishermen and boys by whom they are manned; the number of fish-curers, coopers, and other persons employed in the years 1881 and 1882:

Years.	Fishing boats.	Fishermen and boys.	Fish-curers.	Coopers.	Other persons (estimated.)
1881	14, 809	48, 121	1, 063	2, 398	45, 291
1882	14, 973	48, 296	1, 072	2, 564	47, 464
Increase in 1882	164	175	9	166	2, 173

XI.—HISTORY OF THE TILE-FISH.

BY CAPT. J. W. COLLINS.

A.—INTRODUCTION.

1.—OBJECTS OF THE ESSAY.

In a large country like the United States, with a rapidly increasing population, everything pertaining to the subject of food for the people is a matter of public interest. As is well known, our sea-fisheries are a source from whence is drawn a large amount of the most nutritious food, which, as a rule, can be obtained by the consumer at a moderate cost. This being the case, and the fact existing that some of the most valuable species of our food-fishes are apparently being decreased in numbers to a greater or less extent by overfishing, it is not surprising that much interest should have been felt in the discovery off our coast, in 1879, of a new and valuable food-fish (*Lopholatilus chamæleonticeps*), equaling the cod in size, and occurring in great abundance in the locality where it was found. But when, in the spring of 1882, fish, chiefly of this species, were reported by incoming vessels as having been seen in countless millions floating upon the surface of the ocean in a dead or dying condition, covering thousands of square miles of the sea, it is not at all wonderful that the public interest was very much excited, and that a very general desire to learn more of this species was exhibited. The followl ing extract from an article* in the the Boston Daily Advertiser, Apri- 5, 1882, may serve as a fair example of the consideration which this subject received in the public press:

"Extensive as our list of edible fish is," says the writer, "people will gladly welcome anything new and desirable from lake, stream, or ocean. If to the standard cod, haddock, mackerel, and salmon we may add companionship of some heretofore little known, or quite unknown, fish for the further development of the general fisheries interest, both as regards labor and trade, we shall be fortunate. A living question just now is, whether or no we have a tide in the affairs of fishermen that, taken 'at the flood,' shall lead to good fortune. The excellent edible fish brought to notice by our United States Fish Commissioner not long ago, and so recently found dead and floating in immeasurable numbers upon the surface of the North Atlantic Ocean, may be the 'coming' fish. Not one to supersede the cod and its confreres, but possibly one

* Written by George E. Emory.

providentially offered to enlarge the field of gustatory and commercial possibilities. The Tile-fish found since the late tremendous commotion off our New England coast has been proved to be one of the very best sea-fish known when cooked in a fresh state. It will probably 'cure' well. The flesh is very firm in texture, keeps well, cooks nicely, and is excellent in flavor. The Tile-fish is of suitable size for easy handling in curing, packing, and trade. It exists in apparently vast if not absolutely inexhaustible numbers, along the western edge of the Gulf Stream, and probably about the eastern edge as well. * * * There is possibly in this Tile-fish matter a great opportunity for our Government Fish Commission to do work of real and permanent value, far outweighing any prior labor accomplished by the board. Let the Commissioners at once solve the problem so urgently demanding their attention. With a rapidly increasing demand for edible fish, the enhancement of prices, and the tremendous increase of capital in the country awaiting profitable investment, there ought to be no needless delay in action. How soon will the Fish Commission attempt practical work to demonstrate to commercial circles and fish eaters the practical use served by its existence? The people of the country generally want to know just where to find the Tile-fish; they want to know its habits; they want to know the best seasons and the best means for taking this valuable fish.* * * * Will the United States Fish Commission determine the facts regarding the new fish and a possible new field for fisheries as soon as may be consistent with accuracy and thoroughness?"

The object of this paper is to give, under one head and in a convenient form for reference, all that is known of the Tile-fish, and especially to place on record all the information that it has been possible to gather concerning the phenomena which occurred in the spring of 1882, when these fish were found in extraordinary numbers floating upon the surface of the ocean between Nantucket and the Chesapeake. Soon after this occurrence Professor Baird placed in my hands a large amount of data bearing on the subject, with the request that I should mark on a chart the various tracks sailed through the dead fish by the vessels which reported having seen them; and he also desired that an estimate should be made of the area covered and the probable numbers of floating *Lopholatilus*. Before, however, my other duties permitted the accomplishment of this work, circumstances placed me in a position to acquire much additional knowledge concerning the earliest captures of this fish, besides many other facts which appeared to be more or less

* As will be seen in succeeding paragraphs, Prof. Spencer F. Baird sent out an expedition to the Tile-fish grounds as early as 1880, but, unfortunately, this failed to accomplish its purpose. Another investigation, made by the author in the fall of 1882, under the direction of Professor Baird (a report of which has already been published), failed to obtain any information concerning the *Lopholatilus*, which, at this time, was probably so much depleted by the mortality of the previous spring that none remained on the ground where it had formerly been found.

interesting in this connection. All of this knowledge has been combined with other material at hand, and though necessarily much of this essay must be a compilation, the writer simply supplying the threads to bind together the material which has been gathered from so many sources; it is, nevertheless, hoped that the manner of presenting these facts may make them of some value to those interested in the subject under discussion.

B.—GENERAL CHARACTERISTICS OF THE TILE-FISH.

2.—DESCRIPTION OF THE FISH, WITH NOTES ON ITS CLASSIFICATION.

The Tile-fish has many peculiarities of its own, and, even to the casual observer, presents features which differ essentially from those possessed by any other species found near the same locality. In size it varies from five to fifty pounds; its head is proportionately large, and has a general resemblance to that of the dolphin (*Coryphæna*), and also to that of the wolf-fish (*Anarrhichas*), though differing from both; the body is well formed, quite stout at the tail, like the salmon, and the general make-up of the fish indicates that it is a rapid and active swimmer, well fitted to pursue and capture its food or to escape from its enemies. Its distinguishing characteristics, however, are the nuchal crest or adipose dorsal fin just in front of the spinous dorsal, and the peculiar color which it exhibits, being so profusely spotted with patches of greenish-yellow, that it received the name of "Leopard-fish" from the fishermen who were the first to capture it.

"The liver," says Captain Dempsey, "is small, somewhat like that of the mackerel, and contains no oil. The flesh is oily, and will soon rust after splitting and drying.

"The stomach and intestines are small, the latter resembling those of an eel.

"The swim bladder is similar to that of a cod.

"Some of the fish 'blister' like cusk when taken on deck."*

According to Captain Dempsey, Tile-fish, when caught on hand-lines, are fully as active in their movements as cod, and appear even more lively than the latter species when taken on deck. Captain Kirby, however, who caught them on trawl-lines, says they exhibit less activity than the cod.

The following scientific description of the *Lopholatilus chamæleonticeps* Goode and Bean, was published in the Proceedings of United States National Museum, Vol. 2, pp. 205–208:†

"A few days ago Capt. William H. Kirby, of Gloucester, Mass., took 500 pounds of a remarkable new fish on a codfish trawl in latitude 40°

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* Statement of Capt. William Dempsey, Proc. U. S. Nat. Museum, vol. 2, pp. 208, 209.

† Description of a new genus and species of fish, *Lopholatilus chamæleonticeps*, from the south coast of New England, by G. Brown Goode and Tarleton H. Bean.

N., longitude 70° W., at a depth of 84 fathoms, 80 miles south by east of Noman's Land. One of these was forwarded by him to the United States National Museum, and forms the type of a new genus and species. The single individual secured (No. 22899, Earll 342) is 33 inches long. The largest one taken, according to Captain Kirby, weighed 50 pounds.

"The species appears to be generically distinct from the already described species of the family *Latilidæ* Gill. It is related by its few-rayed vertical fins and other characters to the genus *Latilus* as restricted by Gill, but is distinguished by the presence of a large adipose appendage upon the nape, resembling the adipose fin of the salmonidæ, and by a fleshy prolongation upon each side of the labial fold extending backwards beyond the angle of the mouth. For this genus we propose the name *Lopholatilus*.

"LOPHOLATILUS CHAMÆLEONTICEPS, sp. nov.

"DESCRIPTION.—The greatest height of the body (.306), which is at the ventrals, is contained about three and one-half times in the length to the origin of the middle caudal rays, and four times in the extreme length. Its greatest width (.144) equals the length of the caudal peduncle (.144); this latter being measured from the end of the soft dorsal to the origin of the middle caudal rays. The least height of the tail (.0867) is contained four times in the distance of the spinous dorsal from the snout.

"The greatest length of the head (.33) is contained three times in the length to the origin of the middle caudal rays. Its greatest width (.165) is slightly more than twice the width of the interorbital area (.08). The length of the snout (.122) is contained twice in the length of the pectoral of the right side (.244). The length of the operculum to the end of the flap (.11) is one-ninth of total length. The length of the upper jaw (.15) equals one-half of the height of the body at the ventrals, and is contained two and one-half times in the length of the head. The maxilla extends to the perpendicular through the anterior margin of the orbit; the mandible does not quite reach the perpendicular through the middle of the orbit; the length of the labial appendage is slightly more than half of the long diameter of the orbit and one-third of the length of the first pectoral ray. The length of the mandible (.156) slightly exceeds the distance from the snout to the orbit (.15), and equals three times the long diameter of the eye (.052), which is contained six and one-half times in the length of the head. The operculum and preoperculum are scaly; the latter is finely denticulated on its posterior margin. The distance of the posterior nostril from the eye equals the length of the first anal spine; the distance between the anterior nostril and the end of the snout is twice as great. The intermaxillaries are supplied with an outer series of nineteen canine teeth, and behind these a band of viliform teeth, widest at the symphysis; vomer and palatines toothless.

"The distance of the adipose dorsal from the snout (.206) equals nearly three times its height (.07); its length of base (.123) equals the length of the snout. The height of the adipose dorsal equals the distance from the tip of the ventral to the vent.

"The distance of the spinous dorsal from the snout (.347) equals the distance of the ventral from the snout (.347); its length of base (.144) equals the length of the caudal peduncle. The first spine is imperfect—what remains of it is one-third as long as the third spine (.09). The second spine (.082) is about equal to the width of the interorbital area. The fourth and the sixth spines are equal in length (.097), and equal the distance from the end of the snout to the posterior nostril. The fifth spine (.095) is a little shorter than the sixth. The last spine (seventh) is contained ten times in the total length. The length of the first ray of the soft dorsal (.094) equals the distance between the anterior nostril and the end of the snout. The thirteenth and longest ray (.147), about equals the length of the base of the spinous dorsal. The last ray (.07) is half as long as the thirteenth. The thirteenth ray of the soft dorsal extends to the origin of the external caudal rays.

"The distance of the anal from the snout (.60) is about equal to twice the height of the body at the ventrals. The length of the anal base (.318) is slightly more than twice the length of the mandible. The first anal spine (.04) is half as long as the second dorsal spine. The second anal spine (.075) is half as long as the upper jaw. The first ray of the anal (.102) is as long as the last spine of the dorsal. The eleventh and longest anal ray (.134) is contained seven and one-half times in the total length, and nearly equals the length of the middle caudal rays. The last anal ray (.078) is half as long as the mandible. The eleventh ray of the anal extends almost to the perpendicular through the origin of the middle caudal rays.

"The caudal is emarginate, the external rays being only one and one-half times as long as the middle rays. The length of the superior external rays (.216), measured from the origin of the middle rays, equals one and one-half times the length of the spinous dorsal base.

"The distance of the pectoral from the snout (.32) very slightly exceeds the length of the anal base. The length of the pectoral of the right side (.244) equals twice that of the snout. The pectoral of the left side is probably imperfect, its length (.216) being equal to that of the superior external caudal rays. The right pectoral can be made to reach the vent; in its natural position it extends to the perpendicular let fall from the fourth ray of the second dorsal.

"The distance of the ventral from the snout (.347) equals four times the least height of the tail. The length of the ventral (.183) equals twice that of the third dorsal spine, and it extends to a point under the third dorsal ray. The distance from the tip of the ventral to the vent equals half the length of the middle caudal rays. The vent is under the interval between the fourth and fifth dorsal rays.

"*Radial formula.*—B. VI; D. VII, 15; A. II, 13; C. 18; P. II, 15; V. I, 5; L. Lat., 93; L. Trans., 8 + 30.

"*Color.*—The operculum, preoperculum, upper surface of head, and major portion of the body have numerous greenish-yellow spots, the largest of which are about one-third as long as the eye. Upon the caudal rays are about eight stripes of the same color, some of them connected by cross-blotches. The upper part of the body has a violaceous tint, and the lower parts are whitish, with some areas of yellow. The anal and ventral fins are whitish. The pectorals have the tint of the upper surface of the body, with some yellow upon their posterior surfaces. The soft dorsal has an upper broad band of violaceous, and a narrow, basal portion of whitish. Many of the rays have upon them a yellow stripe; there are some spots the same color, especially upon the anterior portion of the fin.

"NOTE.—In the table of measurements the unit of comparison is the length to the origin of the middle caudal rays."

Table of measurements.

Current number of specimen	22889	
Locality	80 miles S. by E. of Noman's Land.	
	Millimeters.	100ths of length.
Length to origin of middle caudal rays	692	....
Length to end of middle caudal rays	788	....
Body:		
Greatest height (at ventrals)	212	30.6
Greatest width	100	14.4
Least height of tail	60	8.67
Length of caudal peduncle	100	14.4
Head:		
Greatest length	230	33
Greatest width	114	16.5
Width of interorbital area	56	8
Length of snout	85	12.28
Length of operculum	77	11
Length of upper jaw	105	15
Length of mandible	108	15.6
Distance from snout to orbit	103	15
Long diameter of eye	36	5.2
Dorsal (adipose):		
Distance from snout	143	20.66
Length of base	85	12.28
Greatest height	48	7
Dorsal (spinous):		
Distance from snout	240	34.88
Length of base	100	14.4
Length of first spine (possibly broken)	20	3
Length of second spine	57	8.24
Length of third spine	63	9.1
Length of fourth spine	67	9.68
Length of fifth spine (possibly broken)	66	9.54
Length of sixth spine	67	9.68
Length of seventh spine	70	10
Dorsal (soft):		
Length of base	300	43.35
Length of first ray	65	9.4
Length of longest ray (thirteenth)	102	14.74
Length of last ray	48	7
Anal:		
Distance from snout	416	60
Length of base	220	31.79
Length of first spine	29	4.2
Length of second spine	52	7.5
Length of first ray	71	10.26
Length of longest ray (eleventh)	93	13.44
Length of last ray	54	7.8

Table of measurements.

	Millimeters.	100ths of length.
Caudal:		
Length of middle rays	96	13.87
Length of external rays.. superior	150	21.67
Length of external rays.. inferior	145	21
Pectoral:		
Distance from snout	223	32.22
Length.. right side	169	24.42
Length.. left side	150	21.67
Ventral:		
Distance from snout	240	34.68
Length	127	18.35
Branchiostegals	VI	....
Dorsal	VII, 15	....
Anal	II, 13	....
Caudal	18	....
Pectoral	II, 15	....
Ventral	I, 5	....
Number of scales in lateral line	93	....
Number of transverse rows above lateral line	8	....
Number of transverse rows below lateral line	30	....

3.—SYSTEMATIC RELATIONS OF LOPHOLATILUS.

The Tile-fish is a member of the family *Latilidæ*, as classified by Gill, and is most nearly related to the typical genus known as *Latilus*. Other representatives of the family are *Caulolatilus*, *Prolatilus*, and *Pinguipes*. These forms, except *Lopholatilus*, are more especially inhabitants of the tropical and warm seas, but some range both to the northward and southward of the equatorial belt. In detail, the genus *Latilus* is composed of species found in the Chinese and Japanese seas. *Caulolatilus* is confined to the warm waters on both sides of the American continent; *Prolatilus* has a single species, which has hitherto been found only on the Chilean coast, and of *Pinguipes*, there is a species dwelling in the temperate or less heated waters on both sides of South America. *Lopholatilus* is exceptional in its distribution, in that it inhabits deep water in a nearly uniform temperature of about 50 degrees, the variations, according to the observations taken on United States Fish Commission steamer Fish Hawk, being from 42° to 50° Fahr.

All the other forms occur in water of comparatively little depth and near the coast; are apparently moderately abundant in their special regions, where they are considered quite good food-fishes, as a rule, though they do not at all rival the Tile-fish in size.

4.—HABITS; ABUNDANCE; EXTENT OF THE LOPHOLATILUS BANK.

Habits.—Comparatively little can be said of the habits of the Tile-fish. The locality where it has been found is so rarely visited by our cod-fishing vessels that it may be considered the merest chance that the schooners William V. Hutchings and Clara F. Friend went there in 1879. Consequently nothing can be learned from the fishermen beyond the accounts given by Captains Kirby and Dempsey. Comparatively little, too, has been learned by the Fish Commission concerning the habits of this species,

during the past two years, 1880–'81, as I am informed by Dr. Tarleton H. Bean, who had charge of the Department of Fishes. Writing under date of July 10, 1882, he says:

"The amount of knowledge possessed by the United States Fish Commission concerning the food and spawning habits of *Lopholatilus* is small indeed. I do not remember any information about the spawning. Last year we took a good many individuals on the trawl-line and found them gorged with a large species of amphipod crustacean, *Themisto bispinosus* This is all I know about the food; am sorry it is so little."

In regard to the lack of knowledge concerning the spawning, alluded to by Dr. Bean, it may be said that Tile-fish have been taken by the Fish Commission only in August and September, when it is probable that the season of reproduction had passed, since Captain Dempsey says that the fish which he took in June, 1879, were fully ripe and that their eggs ran from them.

The food of *Lopholatilus*, according to Captain Kirby, consists chiefly of crabs of various species, with which the stomachs of the fish he caught in 1879 were filled to repletion. It bites eagerly, however, at fresh menhaden bait, and very likely, at certain seasons, it may feed largely on some species of small fish. Captain Dempsey did not notice any food in the Tile-fish which he caught, but this was due, no doubt, to lack of observation on the part of those who eviscerated them.*

Lopholatilus is evidently a "ground-feeder," like the cod, since it has generally been caught on trawl-lines set at the bottom. Captain Dempsey is of this opinion, and says those he caught on hand-lines were hooked close to the bottom. Captain Kirby, however, thinks they do not remain at the bottom, but "play" up in the water, notwithstanding those he caught were taken on a trawl-line. He was led to form this opinion because the larger part of the fish he captured were on that portion of his gear which, he thought, did not reach the bottom.

In all probability the *Lopholatilus* is essentially a deep-water fish, though our knowledge of it is yet too limited to speak with any degree of certainty on this subject. At the present time it is impossible to say in what depths it may be found in other localities. We only know that it has been taken in from a little less than 90 to 134 fathoms. The area, however, covered by the dead fish in the spring of 1882, a discussion of which is given in another paragraph, would indicate that this species had a much wider range, in regard to depth, than would appear from the captures made on hook and line.

As to the seasons when they frequent the waters off the southern coast of New England, we also know comparatively little. Whether

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* I am told by Mr. Richard Rathbun, that on the first trip on which *Lopholatilus* were taken by the United States Fish Commission steamer Fish Hawk, three specimens were caught, in the stomachs of which were found bones of mutton chops that had been eaten at breakfast on board the steamer. This would indicate that the Tile-fish is quite as voracious as the cod.

they remain during the winter in the region where they have been found in the summer cannot be said. The fact that they were seen floating upon the surface, dead or dying, early in March, 1882, would indicate, at least, that they are on the ground in the latter part of the winter, and as they have been caught on trawls as late as the 13th of September, it is probable that they might remain some weeks longer, if not all the year.*

In regard to other peculiarities, Captain Kirby says that these fish when hauled from the water, do not flap their tails as the cod do under similar circumstances, but seem to be paralyzed. Even when being unhooked they do not make any muscular effort. This is so entirely different from the account given by Captain Dempsey, who caught the Tile-fish on hand-lines, that I feel compelled to notice it, but must ascribe the conflicting statements not to any lack of attention on the part of these observers, but to the fact that the movements of the same kind of fish taken on hand-lines often differ radically from those caught on trawls, since on the latter apparatus they are supposed to exhaust themselves in their continued struggles to escape, so that they frequently drown before the gear is hauled. This is especially noticeable in catching the halibut. One of these on a hand-line will give the strongest fisherman all he can do to haul the gamey fish to the surface, and it almost always happens that the line must be veered out several times or the gear would be torn in two by the active and powerful fish. But caught on a trawl the halibut rarely shows much fight, except in very shoal water, and not unfrequently a doryman will be pulling at once from fifteen to forty of these fish, either one of which, if hooked on a hand-line, would give him all he could do to manage it, and bring it successfully alongside.

Abundance.—Whatever may be the numerical strength of the Tile-fish at the present time, it is beyond question that this species occurred in vast numbers in the waters bordering the Gulf Stream—between Hatteras and Nantucket—previous to the season of 1882, though comparatively little was known in regard to their actual abundance, or the extent of the area where they could be taken. It is true that Captain Kirby had found them so numerous that large catches might have been made on trawls; Captain Dempsey caught them "pair and pair" on hand-lines, and the Fish Commission, during its investigations off the Southern New England coast, had taken more or less of them on sev-

*This refers to the habits of the Tile-fish previous to the great mortality in the spring of 1882. Since that time the investigations made by the Fish Commission steamers Fish Hawk and Albatross and a special cruise made in the smack Josie Reeves, for the purpose of finding *Lopholatilus*, all of which failed to secure a single individual of this species, it seems probable that the survivors, if there were any, have abandoned the locality where they had been previously so abundant. Speculations, therefore, as to their movements, the time they remained on certain grounds, &c., can only apply to that period when they were known to be plentiful in the spring and summer, at least, off the coast of New England.

eral occasions. Nevertheless, we had no adequate idea of their abundance, nor indeed of their importance, until they were observed floating upon the surface of the sea in such masses that even with the most liberal reductions for possible exaggeration on the part of the observers, the mind is confused in calculating the figures which would denote their numbers.

There can be but little doubt that the habitat of the Tile-fish covered a large area, equal in size to some of the most important of the favorite haunts of the cod, and that the fish themselves existed in an abundance nearly approaching to that of the last-named species; but whether or not *Lopholatilus* may be found at present in abundance farther south than it has been taken heretofore is an open question. There seems to be but little reason to doubt the probability of their occurrence in such localities as may be congenial to them for many hundreds of miles along our Southern coast; for, according to the best authorities, its relatives are subtropical species, and it would be likely to occur in Southern waters.

Extent of the Lopholatilus bank.—If we were obliged to confine ourselves simply to the consideration of the area where *Lopholatilus* has been taken on hook and line we would find a range of limited extent stretching along the slope inside of the Gulf Stream, about the parallel of 40° N. lat., and from 70° to about 71° 25′ W. long., in depths varying from about 90 to 125 fathoms. This ground is some 65 miles in length with an average width of, perhaps, 3 to 4 miles. But the dead Tile-fish which were seen floating upon the surface of the ocean in the spring of 1882 gives us a far better conception of the area covered by this species. From a careful consideration of the large amount of data which has been at my disposal I find that these fish were noticed over an area 170 miles in a northeasterly and southwesterly direction, and with an average width of at least 25 miles. This shows them to have covered an area of 5,620 square statute miles, even after making liberal allowances for the drift of the fish by winds and currents. Within this region, then, lying between the parallels of 37° 29′ and 40° 00′ N. lat. and meridians of 69° 51′ to 74° 00′ W. long., we may safely say, is the *Lopholatilus* bank. That this is the only region where these fish occur is not at all probable, and it seems altogether likely that future investigations may demonstrate that the area here spoken of is but a portion of the ground where this species may be found. The researches of the United States Fish Commission have demonstrated the fact that along the slope lying inside of the Gulf stream, between the parallels of 37° and 40° N. lat., and in depths ranging from 80 to about 200 or 250 fathoms there is a band of warm water extending to the bottom of the sea, while inside of it, in shallow water, the temperature is much lower, and at the bottom, in greater depths, beneath the warm waters of the Gulf stream, a cold stratum is also found. This belt of warm water, which seemingly just sweeps the ocean bed in the

locality mentioned, is the home of an immense amount and variety of sea life, among which occurs many tropical and subtropical species, and here also is found the Tile-fish. A full discussion of this subject from the pen of Prof. A. E. Verrill, of Yale College, will be found in a following section of this paper.

5.—USES AND UTILIZATION.

That *Lopholatilus* is a good and wholesome food-fish has been settled by competent authority; though, curiously enough, those who have partaken of it seem to disagree in regard to their estimate of its quality and flavor. Many of these persons say without hesitation that it is one of the finest, if not the best flavored, fish they have ever eaten, while others consider it not especially good in this particular. This species of fish, like some others, the Pompano, for instance, is said to have a flavor peculiar to itself, which to some people is extremely agreeable, while to others it is not so pleasant. From what is known of the Tile-fish it is altogether probable that it would be best relished in a fresh condition, and there is reason to suppose that in case it could be taken in large quantities it might occupy a very prominent position in the fish markets of our sea-coast towns. It might, perhaps, also be a valuable article of food salted and preserved in brine, as are mackerel, but owing to the presence of fat in the flesh it has not been found practical to cure it in the same manner as salted codfish are prepared for market. In the summer of 1879, Capt. George Friend, of Gloucester, smoked some of the tile-fish which were taken by Captain Kirby, and he, as well as several others who ate them, told me that they were excellent when prepared in this manner, rivalling smoked halibut in richness and flavor. On the other hand, Mr. William H. Wonson, 3d, who also smoked the Tile-fish at Gloucester, does not speak so highly of its fine qualities as a food-fish under the same conditions. He says that while it is certainly very good and wholesome, as well as a desirable article of food when smoked, it cannot compete with the halibut, and is no better, in fact, than smoked haddock—the finnan haddies.

Without doubt, the best way of utilizing the catch of the Tile-fish, which possibly may hereafter be found in the localities where they were formerly abundant (off the coast between Nantucket and the Chesapeake), would be to ice the fish, and take them in a fresh condition to the New York and Philadelphia markets, since these ports are in close proximity to the fishing-grounds and could be easily reached while the fish were in good order. Two or three days' work at most would suffice, under ordinary circumstances, to secure a good fare, and one of our swift-sailing fishing-vessels could make the voyage from the Tile-fish grounds to either New York or Philadelphia in from ten to twenty hours, unless the chances were specially unfavorable. Considering that haddock and cod are now brought in a fresh condition to Boston market from Le Have and Western Banks, a distance ranging from 300

to 450 miles, during the winter season, it certainly would be feasible to bring fresh Tile-fish to market over a much shorter distance. That they can be smoked and thus be made an excellent article of food, and that the presence of a certain amount of fat or oily matter in the flesh tends to make them very desirable when prepared in this manner, is a sufficient guarantee that any surplus, however large or small, may be profitably disposed of. Should the Tile-fish ever visit our coast in the future in as great abundance as heretofore, it is more than probable that the fishery for it might be prosecuted with profit to the fishermen, and also that the New York and Philadelphia markets might be supplied at all seasons of the year with this additional and excellent food-fish.

C.—HISTORY OF ITS DISCOVERY AND SUBSEQUENT CAPTURE.

6.—ACCOUNT OF ITS DISCOVERY BY CAPTAIN KIRBY.

The first capture of Tile-fish, as has been stated, was made by Captain Kirby, in May, 1879, while trawling for cod to the southward of the South Shoal of Nantucket, and to him, therefore, belongs the honor of obtaining and presenting to the United States Fish Commission the individual specimen which forms the type of this species. In the description of *Lopholatilus*, already quoted, reference is made to this circumstance, but for obvious reasons it is deemed unnecessary to repeat it here. A more detailed account of this capture of the Tile-fish, together with the causes which led thereto, may, however, prove of interest, and is therefore given on data furnished by Captain Kirby.

In the spring of 1879, one of the halibut schooners that had been fishing in the deep water to the southward of the South Channel and George's Bank, reported an abundance of hake (*Phycis chuss* and *P. tenuis*) in that region. Captain Kirby heard of this rumor, but his informant told him that the locality where these hake were taken was to the southward of the South Shoal of Nantucket. The reported abundance of these fish received at that time more than ordinary attention from the fishermen, since the extreme high price then paid for hake sounds—swim bladders—together with the large yield of oil obtained from the livers, added to the worth of the fish for food purposes, rendered its pursuit and capture an object of unusual importance. Influenced by these considerations, Captain Kirby, who had been engaged in cod-fishing on the banks north of Cape Cod during the spring, decided to investigate the matter and to learn by actual trial whether or not the rumor was based on fact. Accordingly he proceeded to Greenport, Long Island, and having obtained there a good supply of fresh menhaden for bait, he started for the fishing-ground.

Passing out between Montauk Point and Block Island he ran off on a south southeast course about 68 miles, where a depth of 80 fathoms was obtained, the position being lat. 40° 07′ N., long. 70° 59′ W.

Having reached this locality, which was supposed to be a favorite one for hake, a "set under sail" was made.* No favorable results being obtained on this and another set of the trawls which was made the same day to the northwest of the first, in shoaler water, and the weather remaining moderate and clear, the vessel was allowed to head to the eastward during the night, sailing slowly in that direction. As it was moderate, she probably did not go more than 20 or 25 miles.

On the following morning another set was made in the same manner as before, four trawls, each having 1,000 hooks, being put out. The first ends of the lines were thrown out in about 80 fathoms, from which they were run in a southerly direction. The length of each of the trawls was a little more than a mile, and, having been set where the bottom slopes quite rapidly towards the deep valley of the Gulf Stream, it was found when the gear was hauled that, though the buoy-lines on the outer or deep-water ends were each 120 fathoms long, a portion of the trawls had not reached the bottom. This set was made in lat. 40°, 04′ N., long. 70°, 23′ W.

One of his men being too ill to work Captain Kirby went out in a dory himself to assist in hauling the gear, leaving the cook in charge of the schooner. He (Kirby) says that little was caught on the portion of the trawls set in the shoalest water, but on about one-fifth of their length—that part set last, some of which, as previously mentioned, did not reach the bottom, being, as Captain Kirby thinks, in about 150 fathoms—a strange and handsomely-colored fish was taken in great abundance, each of the dories securing a catch of thirty or forty indi-

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* The term "set under sail," or "flying set," implies that the vessel, instead of being anchored, as is the most common way on the Banks when trawls are to be set, is kept under way, the performance taking place as follows:

The depth of water having been first ascertained by the skipper, he then orders the dories to be made ready. This puts all hands on the alert, especially the crews of the top dories, who quickly arrange in them the buoys, buoy-lines, etc., that are required. Having made all necessary preparations, the top dories are hoisted over the rail, where they are left to hang until the next are ready, when they are lowered into the water. The trawls are then put in and the men take their places in the dories, when the boats are dropped astern, the painters being fastened to the stern of the vessel. In the same manner the other dories are prepared and hoisted out.

When all are ready, and the proper time has arrived, the vessel usually stands along by the wind, dropping first one dory and then another about one or two hundred fathoms apart, when the men in them proceed to set the trawls in the usual manner, generally rowing the dories to leeward in a direction nearly at right angles to the vessel's course.

The first dory's crew are usually almost done with their work by the time the vessel has dropped the last boat. The schooner then keeps off and runs down to pick up the first and the other boats in succession, as they each finish setting their gear. This done, she lies by until it is time to haul, when the vessel is run along from buoy to buoy, dropping each dory near its own trawl. The men in the boats then proceed to pull in their lines, the vessel in the mean time lying by waiting, or running from boat to boat to ascertain what success they meet with. The holding up of an oar is a signal that the men have finished hauling their trawl or want help, seeing which the vessel runs down and receives the cargo or takes the boat in tow.

viduals, equal to a total of nearly 2,000 pounds, all of which, however, with the exception of a few specimens, saved as a curiosity, were thrown away. The weather continuing fine, with light winds, two more sets were subsequently made under sail, the first of these about 3 to 4 miles (lat. 40° 04′ N., long. 70° 17′ W.), and the last some 10 or 12 miles in an easterly direction from the position where the Tile-fish were first taken. On each of these trials some of the *Lopholatilus* were caught, though the chief part, however, were taken on the last haul in the deepest water reached by the trawls, ranging from 100 to 130 fathoms, the position being lat. 40° 00′ N., long. 70° 04′ W.

In the mean time Captain Kirby had some of the new fish cooked, and as they were (as he says) the finest fish he ever ate, he decided to save and salt all that he might take thereafter. Accordingly, those caught on the two last-mentioned sets were split and salted in kench, like codfish, a single specimen only being saved in ice.

Not having met with satisfactory success in taking cod or hake in the trials above described, few or none of these species having been caught, Captain Kirby went farther to the eastward, and finally anchored in a depth of 120 fathoms south by east from the light-ship on the South Shoal off Nantucket, in which locality no Tile-fish were captured.

On the arrival of the vessel in port, the salted *Lopholatilus*, about 2,000 pounds in all,* were sold to Messrs. George Friend & Son, who smoked a portion of the fish and disposed of the remainder as opportunity offered, giving away, however, many of them to neighbors and acquaintances.

7.—ACCOUNT OF THE CAPTURE OF TILE-FISH BY CAPTAIN DEMPSEY.

In the published description of *Lopholatilus* is also the following notice of a second capture of this species by the schooner Clara F. Friend, Captain Dempsey, of Gloucester, which occurred a short time subsequent to that which has just been described.

"Capt. William Dempsey, of Gloucester, has since furnished nine fresh specimens of this *Lopholatilus*, and the following information:

"'The fish were caught with menhaden bait, in July, 1879, while

* It will be noticed that there is a decided difference in the amount of Tile-fish said to have been taken by Captain Kirby in the published account already quoted and that given here. I am satisfied, however, that the latter is the most nearly correct, since the statements obtained from Mr. Friend relative to this matter coincide with those made by Captain Kirby. Taking into consideration, therefore, that these fish, in a salted condition, did not weigh much more than two-thirds the amount that they would have weighed when fresh, and also including the 2,000 pounds which were thrown away, it will be seen that a total of at least 5,000 pounds of Tile-fish were caught on *only a small portion* of 4,000 hooks that were set three times. The great abundance of the *Lopholatilus* in that locality in 1879 is, therefore, apparent. It is altogether probable that a vessel setting 12,000 hooks, which is about the average number, and placing those to the best advantage on the Tile-fish ground, would have taken anywhere from 15,000 to 20,000 pounds on a single set of the trawls.

"trying" for cod 50 miles south by east of Noman's Land, in lat. 40° 10′ N., long. 70° 55′ W., 75 fathoms, on very hard clay bottom. Two miles inside of this bottom there is nothing but green ooze, on which no fish will live.

"'Two of the nine fish were spent females. The few remaining eggs of these two were not so large as those of the herring, and resemble the eggs of the Norway haddock. The other seven had nothing to determine whether they were male or female.'"*

The following additional details concerning the taking of the Tile-fish by Captain Dempsey are given on the authority of statements made by him:

Being engaged in the George's hand-line codfishery for which menhaden is the most desirable bait, in summer, Captain Dempsey, in July, 1879, visited Newport, R. I., for the purpose of securing a supply of this needful article. This having been obtained, he ran off from Beaver Tail on a south-southeast course, a distance of about 140 miles, where he sounded, but got no bottom. Feeling desirous of "trying the ground" in order to ascertain if any cod, hake, &c., could be taken in this little known region, he stood back to the northwest until he sounded in 87 fathoms, his position being lat. 40° 02′ N., long. 70° 07′ W. The vessel was hove to and three of the crew put out their hand-lines to "try" for cod.†

*Proc. U. S. National Museum, Vol. II., pp. 208, 209.

It seems desirable to call attention here to the discrepancy that appears (in giving the locality where these fish were caught) between the position indicated by the latitude and longitude given, and that which the course and distance from Noman's Land would place the vessel in. The two statements, though evidently intended to point to the same place, give us two positions which are separated at least 30 miles. This is, without doubt, due to an error of information, and would, perhaps, hardly deserve particular notice, were it not that a careful investigation of the matter, together with the advantage of consulting a chart used at the time, by Captain Dempsey, convinces me that both of these positions are erroneous to a greater or less extent. Of course, in forming this opinion, I depend wholly on the information furnished by Captain Dempsey, who has, in my presence, carefully laid out the course and distance which he ran after taking his departure from the land, and has marked the position where he found the Tile-fish so abundant.

A difference will also be noticed between the depth of water (75 fathoms) given in the published statement, and that (87 fathoms) which Captain Dempsey now remembers to have taken the *Lopholatilus* in. Captain Dempsey is positive that he took the fish in the greatest depth mentioned, and this seems all the more probable, since it agrees with the observations made by Captain Kirby, and also by the United States Fish Commission, neither of them having been able to find Tile-fish in water as shoal as 75 fathoms.

†Under such circumstances a "trial" is made in the following manner, namely: The main-sheet is eased off and the boom hauled out by a tackle, the jib is then hauled down, the fore-sheet slacked away as required, and the helm put hard down. Unlike the mackerel schooner, which always lays to on the starboard tack, the cod hooker is hove to on whichever tack she happens to be on, or on which she will head the current and make the best drift.

As soon as the headway of the vessel stops the lines are baited and put out, the fishermen always standing at the rail on the weather side of the deck.

"As soon as the leads struck the bottom," says Captain Dempsey, "each man caught either a pair or a single fish, such as we had never seen before, and which, from their manner of biting and their movements while being hauled, we supposed were cod until they were brought to the surface of the water alongside of the vessel.

"We put our lines out a second time with the same result, obtaining in all nine of these fish, which we gutted and packed in ice.*

"As there was no indication of the presence of codfish (indeed we caught nothing but Tile-fish), we left the locality and proceeded to the fishing-grounds with which we were more familiar, and where we completed our fare."

8.—CAPTURES MADE BY THE UNITED STATES FISH COMMISSION.

During the summer of 1880 the United States Fish Commission established its headquarters at Newport, R. I., and the following year its summer station was at Wood's Holl, Mass. Both seasons extensive explorations were made by the Fish Commission steamer Fish Hawk of the sea bottom lying off the south coast of New England, on the inner edge of the Gulf Stream slope, in depths varying from 70 to 700 fathoms.

Very important results were obtained in these researches, of which it is not necessary to speak at length here any further than relates to the subject under consideration. On several occasions many of the Tile-fish were taken on a trawl-line. Professor Verrill, writing in the fall of 1881, says: "It seems to be very abundant over the whole region explored by us in 70 to 134 fathoms. On one occasion a 'long-line' or 'trawl-line' was put down at Station 949† in 100 fathoms, and 73 of these fishes were taken, weighing 541 pounds."‡

August 9, 1881, eight individuals were caught on a trawl-line in lat. 40° 01′ N., long. 71° 12′ W., the depth being 134 fathoms; bottom, sand and mud; surface temperature, 69°; bottom, 50°.

September 13, 1880, three Tile-fish were caught on muddy bottom in 126 fathoms, lat. 39° 56′ N., long. 70° 54′ W. Surface temperature, 71°; bottom, 50°.

9.—FAILURE OF THE EXPEDITION SENT TO THE TILE-FISH GROUNDS IN 1880.

So desirous was Professor Baird to obtain fuller knowledge of *Lopholatilus*, which had been pronounced an excellent food-fish, that during his stay in Newport in 1880 he chartered a Noank fishing smack, the Mary Potter, 44 tons, with her crew, to visit the Tile-fish grounds and ascertain in a practical way the abundance of these fish, and, so far as

* These were the specimens mentioned as having been obtained by the United States Fish Commission.

† August 23, 1881, lat. 40° 03′ N., long. 70° 31′ W.; depth, 100 fathoms; mud; surface temperature, 66°; bottom, 52°.

‡ *Notice of the remarkable Marine Fauna occupying the outer banks of the Southern coast of New England*, No. 2, by A. E. Verrill. American Journal of Science, Vol. XXXII, October, 1881, p. 295.

possible, the extent of the area of their occurrence. Two members of the United States Fish Commission, Mr. Vinal N. Edwards and Mr. Newton P. Scudder, also went on the smack. No satisfactory investigation was made, however; for the captain, fearing that he would be caught out in a storm, which he thought was imminent, returned to port without having secured a single specimen of *Lopholatilus*, or, indeed, without having made any determined or persistent effort to accomplish the object of the expedition.

The following account of the cruise has been furnished by Mr. Edwards, and presents in detail all that occurred during the trip:

"September 29, 1880, we left Newport, R. I., at 5 o'clock a. m. in the smack Mary Potter, Captain Potter master, with a crew of four men, and Mr. Scudder and myself. The wind was strong from the westward, and, after we had run off about south southeast from Block Island, it increased in strength and hauled to the northwest. We then took in the foresail, tacked ship, and stood back towards Block Island, under which we anchored at 5 o'clock in the afternoon. Here we lay all night, the wind in the meantime blowing strong from the northwest. On the morning of September 30 the weather was clear, and wind still fresh from the northwest. At 7 o'clock a. m. we got under way, and ran offshore under the three lower sails on a south by east course. At 5 o'clock p. m. we took in the foresail, and hove to and sounded, getting a depth of 80 fathoms. We lay to until daylight or the next morning, when the wind moderated very rapidly, becoming calm in three hours. Having sounded at dawn in 95 fathoms, we ran south for two hours, when we found a depth of 127 fathoms. Here we sat a trawl of 400 hooks, baited with menhaden, and left it out three hours. When hauled, we got on it one swordfish, weighing 500 pounds, and two skates, but nothing else. After hauling the trawl we ran to the eastward, expecting to set again, but the wind breezed up from the northeast, and looked as if there was going to be a blow, and, possibly, a gale, from that direction. Therefore, the captain thought it best to run for Block Island, and we accordingly stood in by the wind for the land, heading along about north northwest until 12 o'clock midnight, when the wind moderated and veered to the eastward. On the morning of October 1, which was nearly calm, we went off in a boat and caught some crabs, shrimp, and small fish. At 9 o'clock the wind sprang up from east southeast, and at 11 o'clock we made Block Island. We then ran for Newport, where we arrived at midnight."

D.—THE MORTALITY AMONG THE TILE-FISH.

10.—THE DEAD FISH.

The reports brought in by vessels arriving at the principal Atlantic sea-ports during the months of March and April, 1882, of great numbers of dead fish having been seen floating at the surface of the sea, over an

extensive area inside of the Gulf Stream, between the latitudes of the Chesapeake and Nantucket, created a widespread public interest. Such a phenomena had never before been known to occur off the northeastern coast of the United States, and the various phases of this wonderful event received much attention from the press, which recorded a great deal of information concerning this remarkable mortality among the fishes.

The following, which is one of the earliest notices of dead fish having been seen floating upon the surface of the ocean to the southward of Nantucket, appeared in the Boston Advertiser of March 21, 1882. It will be observed that the victims of the extraordinary fatality which is here described were supposed to have been codfish:

"It was reported yesterday that the Norwegian bark Sidon, which had just arrived from Cardenas, had sailed, when in latitude 40° and longitude 71°, through large quantities of dead codfish, which lay floating upon the waters over a distance of 50 miles of the vessel's course. The bark is now lying at Gray's wharf, at the North End, where she will discharge her cargo of sugar. In a visit to her berth yesterday afternoon the writer found the captain to be absent, but the mate and one of the crew who were on board, verified substantially the fish story, though they toned it down considerably in respect to the distance sailed, which the seaman, who said he saw the fish, thought might be 10 or 12 miles. It was the mate's watch below at the time, and he could say nothing from ocular knowledge, though he did not doubt the testimony of all who were on deck at the time. The floating fish were of large size, and were visible on both sides of the ship as far as the eye could reach. An attempt was made to catch one of them with a boathook, but the vessel was sailing so fast that it proved impossible to do so. The mariners have no theory to account for this fish fatality, but say they never saw or heard of the like before. The fact—for there is no reason to doubt the story of the seamen—has certainly an interest beyond that of a mere momentary wonder, for it may serve to explain the unwonted scarcity of fish complained of in some seasons. It has been the fashion to accuse the 'trawlers' of being the guilty cause of these disappearances of fish, and it has been declared that the codfish will soon become as extinct as the dodo unless this practice of trawling were given up, and the old honest way returned to of fishing with a single line and taking out from the sea one fish at a time. More recently lament was made about the invention of a new sort of 'exterminator,' in shape something like a drag-net, which is hauled along the bottom of the fishing vessel under sail, and scoops in thousands of fish in a few hours. However ruinous these practices, it would seem that they are quite eclipsed by the mode of destruction, whatever it may be, of which the mariners of the Sidon saw proof."

The following letter to Prof. Spencer F. Baird from Mr. Joseph O. Proctor, one of the leading citizens of Gloucester, Mass., inclosing the

foregoing newspaper paragraph, shows what an interest was felt in the sea-coast towns of New England concerning this event, and demonstrates most forcibly how the welfare of large communities engaged in the fisheries might be affected were such a mortality to occur among the species of fish most commonly sought for food:

"DEAR SIR: The inclosed paragraph was clipped from the Boston Advertiser of to-day. I have heard nothing more about it than what I read in this article. I call your attention to the matter with the thought that you would cause such an investigation to be made as would give you all the information obtainable. All kinds of ground fish have been very scarce on this shore all the winter season, and our vessels that fish on George's, Brown's, or Le Have Banks, have not found what they call a school of fish for many months.

"GLOUCESTER, MASS., *March* 21, 1882."

As the bark Sidon was one of the first to report the presence of the dead fish at sea, the following letter to Prof. Baird, from the secretary of the Boston Fish Bureau, Mr. W. A. Wilcox, containing many additional details, is of special interest:

"DEAR SIR: I have just seen the master of the bark Sidon, from Cardenas, West Indies, to Boston. The captain, Ole Jorgensen, reports as follows:

"Tuesday, March 14, in lat. 40°, long 71°, from 1 p. m. until dark they sailed through large numbers of dead fish floating on the water. The weather was cold and stormy, with strong northwest wind. The vessel was sailing from 6 to 8 knots an hour, equal to 40 or 50 miles, in which they passed through the fish. They attempted to catch some of them, but did not succeed. He judged the fish were from 1 to 4 feet long—mostly from 1 to 2 feet. They could be seen in all directions as far as the eye could reach, but only *scattering*, sometimes as many as twenty being seen at a time near the vessel. The captain could form no estimate of the numbers seen, and could only say it was *many thousands.* As the sea was quite rough they could be seen only as they came up on the crest of the waves. The next day, March 15, they had a gale, accompanied by a snow-storm, and no fish were seen, although they may have passed through them.

"The bark Henry Warner is reported to have passed through the fish in lat. 37°, long. 71°. I regret I could not see the master. The vessel is now at Portland, Me., and I presume a letter will reach him there.

"If you can give me a description and some account of the Tile-fish I shall be very much obliged. Our papers would like it and be pleased to publish it, with your request for any information in regard to those seen floating on the sea. Are they not the species taken by the Fish

Hawk in 1880, and that you sent a sailing vessel after in 1881, the vessel securing a few and ran home from a threatening storm?

"Any information you can give me will be thankfully received, and if I can find out any more of interest I will let you know at once.

"BOSTON, *March* 28, 1882."

Four days before the crew of the Sidon had seen the dead fish the brig Rachel Coney, Capt. Lawrence Coney, of Bangor, Me., had passed over nearly the same track.

I am indebted to Mr. A. R. Crittenden, of Middletown, Conn., for valuable information relating to this event, which he obtained during a personal interview with Captain Coney.

The Rachel Coney sailed through the dead fish on the 10th of March, a distance of about 40 miles on a north-northeast course. "They were first noticed," says Captain Coney, "about 75 miles south-southwest from the light-ship on the South Shoal of Nantucket, and we continued to see them for seven hours, the brig running along about 6 knots."

Captain Coney makes special mention that the largest of the fishes seen, which were from 2 to 3 feet long, were remarkable for having many large bright spots on the back and dorsal fin, and also for "a curious fin on the back of the head or nape," which he calls the "pilot fin." This description, supplemented by a rough drawing made by Captain Coney and forwarded to me by Mr. Crittenden, proves unquestionably that the largest of these floating fish were *Lopholatilus* and *not* cod, as reported by the Sidon. Another species of fish seen by Captain Coney, and which he has also roughly figured, was undoubtedly the *Peristedium miniatum*, of which fuller mention will be made in a succeeding paragraph.

About the same time that the bark Sidon arrived in Boston (possibly sooner) the bark Plymouth reached New York, and the captain of the latter vessel reported having sailed through dead fish for a distance of *sixty-nine miles*. The following paragraph from the New York Tribune gives the result of an interview with the captain of the Plymouth:

"At the office of State Fish Commissioner E. G. Blackford, it was reported yesterday by Captain Lawrence of the bark Plymouth, of Windsor, Nova Scotia, that he had seen a great quantity of dead codfish in the waters off the George's Bank. A Tribune reporter called on Captain Lawrence to learn the facts. The story as told by him was as follows: 'A week ago last Saturday we were sailing off the George's Bank. About daylight on Sunday morning the mate came down into the cabin and said that the bark was passing through a lot of dead codfish, and wanted to know if he should get some of them. I went out on deck and saw that the water all around us and for miles back of us was filled with these fish. Their gills were red, and upon scooping up some of them I found that they were hard, showing that they had not been dead very long. From 6 o'clock in the morning until 5 o'clock

in the evening we were passing through this school of codfish, and as we were sailing at the rate of 6 knots an hour we went through 69 miles of them.'

"'Did you eat them?' inquired the reporter.

"'No,' said Captain Lawrence; 'not 69 miles of 'em. We ate a few.'

"'And this is not 'a fish story?"

"'Hardly. Three other vessels report the same facts.'

"'Sixty-nine miles of dead fish are some fish,' suggested the incredulous reporter.

"'You're right,' said the captain, 'and that's the point of the story. They weren't all cod; there was a kind of fish looking like sea bass; and, also, a lot of red snappers. We also found some broken ships' 'knees.'

"'How do you account for this?' the reporter asked of Captain Mortimer, of the Black Ball Packet Line, who was standing in Mr. Blackford's office.

"'Well,' said Captain Mortimer, 'I don't know that I can. If they had died of disease they would have drifted off to the southward, for the current known as the polar current is now running very strong. It's not unlikely that the icebergs grounded off the Bank may have made the water so cold that they couldn't stand it. But cold water doesn't affect codfish, does it, Mr. Blackford?'

"'No,' said the fish commissioner, 'cold water wouldn't affect them, unless they were salt. I don't know what it was. I'm going to acquaint Professor Baird with the facts. It is a matter of interest to the Commissioners.'

"'When I first reported the facts here in the city,' said Captain Lawrence, 'I said there were 15 miles of them. I thought everybody would think it a 'fish story' if I said 69 miles.'"

As will be observed, the most of those who first saw the dead fish were of the opinion that they were all, or nearly all, cod, or, at least, that they belonged to that family. The accounts as to the kinds seen were so conflicting, and the popular names given to fish by seamen differ so widely, that only a conjecture could be formed as to the identity of the species to which this mortality had occurred. A writer in the New York Times of March 26, 1882, alluding to this subject, says:

"In the determination of the kind of fish just found at sea, the United States Commission met with a great deal of difficulty on account of the uncertainty of the descriptions given by captains and sailors. The vulgar nomenclature of fish is of the most extraordinary kind. A Jersey fisherman will call the most ordinary fish by a local name, while if the same fish were caught by a Delaware or a Boston fisherman, the name being changed, the exact kind of fish meant would be quite unrecognizable. Some said these fish were shad, others bass; some declared them to be red snappers."

Professor Baird, however, from the first, suspected that the fish seen dead and floating in such immense numbers at sea were Tile-fish, and he immediately instructed his correspondents in the principal sea-ports to collect all possible information bearing on the subject. The following letter was sent to Mr. Eugene G. Blackford, New York State fish commissioner, a gentleman well and favorably known for the interest he has always shown in matters connected with the scientific study of Ameiican fishes:

"MY DEAR MR. BLACKFORD: I wish very much you would gather up all the information you can in regard to the occurrence of the dead fish, and also any indications observed which may lead to a definite conclusion as to what kind of fish they were. So far as I can judge from Boston and New York papers, they, in part, at least, were Tile-fish. It is possible, their appearance being almost concurrent with, or but slightly subsequent to, the great storm off George's Bank, that the commotion of the waters may have killed the fish by concussion and started them shoreward. It is a thousand pities that fishermen and others have not sufficient intelligence or curiosity on such occasions to bring specimens home and have them carefully examined. The fact that there was no evidence of disease, but, on the contrary, the fish were palatable and sound, would suggest that the cause of death was rather a mechanical one.*

"WASHINGTON, *March* 24, 1882."

At the same time, however, that the above letter was written to Mr. Blackford, a specimen of the dead fish was being forwarded to Washington from Philadelphia, accompanied by the following letter from James W. Rich to Professor Baird:

"DEAR SIR: I send you by express to-day a sample of the fish picked up off Nantucket, about 70 miles southwest. They appear to be different from any fish I have yet seen, and I cannot find any old fishermen that have seen anything just like them. We sailed through some 60 or 70 miles of them, and they appeared to be rising to the top of the water all the time. Their eyes and blood were as bright as could be when taken on board. I see several vessels have passed through them as codfish, but they are different from the ordinary codfish. I shall be pleased to hear from you when convenient, as I would like to know what the fish are and where they come from.

"PHILADELPHIA, *March* 24, 1882."

The receipt of this specimen, which proved to be a Tile-fish, solved the problem in regard to the species to which the chief part of the dead fish belonged. Referring to this, the New York Times remarks: "It

* This letter appeared in several of the leading New York dailies and also in other newspapers.

will be seen from this letter,* as Professor Baird believed, that the fish was the *Lopholatilus*, or Tile-fish—how shrewd a guess he made."

On receiving the letter from Captain Rich, Professor Baird sent him a telegram and also wrote to him to obtain further details, which the former supplied in the following replies:

"DEAR SIR: Your telegram is at hand, and I am sorry to say I had all the fish cleaned and put on ice. I expect to sail for Boston early next week, and if I come across any more of them will try to get some and ship to you whole. I could discover no appearance of disease about the inwards of any of them; the eyes, gills, blood, and liver were as bright as when living. The liver would not float, and had very little, if any, oil in it. What the fishermen call the 'poke,' or pouch (of a hake), was hanging out of the mouths of about one-half of them, and there was no food of any kind except in one, a small dogfish. I did not try the temperature of the water, but the air was very cold and made heavy ice on deck that night.

"PHILADELPHIA, *March* 25, 1882."

"DEAR SIR: Yours of the 23d is at hand and noted. We first noticed the dead fish about daylight on the morning of March 15, in latitude 40°, and sailed through them on a west by south course from longitude 70° to 71°. When first seen there were a few redfish with them, but when we lowered the boat there was nothing but the Tile-fish in sight; none of them were alive, but none of them swollen, but they appeared to be coming up all the time. Sometimes there would be only two or three in sight, and at others thirty or forty of them. I have seen fish in the winter at the mouth of rivers in South Carolina that would rise to the surface dead yet bright as these fish were, apparently chilled from striking the cold water, and my theory is that the Tile-fish were killed by the cold water, as I found nothing that appeared to be diseased about them.

"PHILADELPHIA, *March* 27, 1882."

Other vessels arriving at this time reported having seen the masses of floating fish, and a few succeeded in obtaining specimens, which were eaten. But, strange to say, with the exception of the one brought in by Captain Rich, none were saved for identification by the captains of the incoming vessels. A writer in the New York Times of March 26, 1882, gives the following account of an interview with the captain of the bark Elizabeth Ostle, one of the few vessels which secured specimens of the *Lopholatilus*:

"Going on board of the bark Elizabeth Ostle, Capt. O. Lamb, just from Calcutta, now moored in Brooklyn, near the Wall-street ferry, the

* The letter written by Professor Baird to Mr. Blackford March 24, 1882, quoted above.

commanding officer having reported the presence of such fish, a series of interrogatories were presented to him by one of the members of the American Fish-cultural Association, who was accompanied by Capt. John Mortimer. Captain Lamb said that on the 21st of March, when about 65 miles off-shore from Barnegat, he sailed for 40 miles at least through waters filled with these dead fish. Having been asked if he could describe the number of fish in a given area, taking his ship's cabin as indicating the space, Captain Lamb replied that 'there would be fully 50 dead fish within that space. The sea was quiet and we were going about from 4 to 5 knots an hour, and we sailed for some seven to eight hours, say 40 miles, with these dead fish alongside of us. There were millions of them. From my log I find that the exact locality was 39° 7′ north latitude, and the longitude 73° 10′ west. We had been sailing all the morning north by west, and were well inside of the Gulf Stream. The temperature was 45°. We found these fish when we could not get soundings.' Captain Lamb had not eaten any of the fish, but calling in the carpenter, who had partaken of the fish, having caught two of them, the man was questioned. 'The fish was a curious fish,' the carpenter said. 'He had never seen the like before. There was in the crew a Nova Scotia man, and he did not know what kind of a fish it was. I took two, and they were fresh and sound. The gills were red, and they bled when opened. The head was curious—different from what I had ever seen on a fish before. One thing I took notice of was a certain lot of yellow spots on the sides of the fish. They would weigh about from 8 to 9 pounds.'"

A single individual only of the dead fish was secured by the bark Alf which arrived in New York March 24, 1882, but her captain was very positive that he saw several species of dead fish besides the Tile-fish. The following account of an interview with him is taken from the New York Herald of March 28, 1882:

"I am Captain Larsen, of the Norwegian bark Alf. I arrived in New York on March 24. On Wednesday last, when just inside the Gulf Stream, about 70 miles south-southeast off Sandy Hook, I saw for 60 miles scattered over the water thousands of dead and dying fishes. This was in about 15 fathoms of water. I noticed four different varieties. I do not know the names of any. I picked up one but did not eat it. (From the captain's description it was evidently a Tile-fish.) The majority of the fishes floating about were similar to it, but dispersed among them there were queer looking fishes, all red on top, that had two protruding horns. These were smaller in size than the fish I secured, which was 2½ feet in length. Besides these there were large, flat, brown-looking fishes, and thousands of small fishes, shiny in color, about a foot long."

In the same paper is given another captain's statement.

Captain Porter, of the bark Avonmore, said: "I have just arrived in port. On March 25, when in north latitude 39° 15′ and about 100 miles

off land in a southeasterly direction from Barnegat Light, we passed for four hours, sailing under a 5-knot breeze, through thousands of dead fishes which were floating on the water, which was quite calm. The fish were grouped together in lots of a dozen or more, while others were scattered singly. During all this time they were never out of sight. I did not try to pick any of them up. They looked like catfish, and were about a foot and a half long. Since my arrival a number of captains have spoken to me about seeing the dead fishes; but from what I can gather I believe there were a far greater number of fish to the northward than on the course I was sailing."

These reports were supplemented a few days later by the following letter to Professor Baird from the secretary of the Boston Fish Bureau, who was indefatigable in securing information relative to this subject:

"DEAR SIR: I fear you may be tired of hearing of the 'dead fish,' but I will venture to give you the report of Capt. I. B. Foss, of schooner Navarino, from Mobile to Boston:

"He first noticed large numbers of dead fish floating in the sea Tuesday, March 21. At that time in latitude 30° to 40° N. longitude about 72° 30′ W. Passed through the fish on that day and night, and also the 22d all day, during which time they must have sailed at least 150 miles. The fish were scattered over the seas as far as could be seen; at times quite thick; hundreds near the vessel. While most of the fish were strange to captain and crew, they were quite sure a small portion of the largest were *cod* and *hake*. The fish appeared to be from 1 to 4 feet long, mostly from 1 to 2 feet. Not any of the fish were secured. Weather at the time cold, with strong northwest wind.

"The master of schooner Lena R. Storey I have not seen, but am told that he reports the same as above, only he was three days behind the Navarino. He also says that he knows some of the largest fish were cod.

"In my previous report of brig Sidon, the master reported the date March 14. I think he was mistaken just one week, as all other reports were the 21st. I regret that he had sailed ere I could see him to correct the date if in error.*

"Thanks for yours of the 31st. I shall be pleased to receive the cut of the Tile-fish, and anything that you can give as to the cause of the destruction will be of interest. The general opinion expressed here is that the fish were killed by some volcanic or other great convulsion of nature. Much interest is taken in the matter.

"Gloucester firms are contemplating sending a vessel out after Tile-fish if they are not all killed. * * *

"BOSTON, *April* 3, 1882."

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* The date given, March 14, is without doubt the correct one. It could not have been the 21st, as Mr. Wilcox supposes, since on that date the account of the circumstance appeared in the Boston papers. Some of the vessels which arrived at New York reported seeing the dead fish several days earlier than the Sidon.

This, it was supposed, completed the history of this wonderful event, and the excitement and interest that had been created by this spectacle of thousands of square miles of the sea covered with dead fish it was scarcely expected would be revived. Mr. Barnet Phillips, of the New York Times, a gentleman much interested in all matters pertaining to the scientific study of the fishes, impressed with this idea, collected as full a list as he could of the vessels which had sailed through the floating fish and sent it to Professor Baird.

Below is the list and other data sent by Mr. Phillips:

Bark Plymouth, arrived in New York March 15, 1882, found fish off George's, March 3.

Bark Montreal, arrived in New York March 13, 1882, found fish off George's.

Steamship Beila, arrived in New York March 21, 1882, found fish 60 miles south of Barnegat on the 20th of March.

Ship British America, arrived in New York March 21, 1882, found fish 45 miles south of Shinnecock on March 20.

Bark Elizabeth Ostle, arrived in New York March 23, 1882, found fish in latitude 39° 7′ on March 21. (Reported in full in New York Times.)

Bark Sidon, arrived in Boston March 21, 1882, found fish in latitude 40°, longitude 71°, on the 14th of March.*

But, strange to say, about a month after the events related above, and just two weeks subsequent to the date of Mr. Phillips's letter, dead fish were found floating off the capes of Virginia, by some of the Gloucester mackerel schooners, and specimens of these were secured and brought into New York by the fishermen, many of whom have for several years shown much interest and enthusiasm in collecting material that they think may aid Professor Baird in his scientific research of American waters.

The New York Times of April 22, 1882, thus describes the arrival of these specimens in New York:

"Yesterday the New York State fish commissioner, Mr. E. G. Blackford, had on exhibition one of the largest of Tile-fish which has yet come to hand. It weighed, when gutted, 43 pounds, and was, when entire, a bigger fish than the one caught by Captain Kirby some few years ago. The fish, with its peculiar large head, its nuchal crest—that long adipose fin projecting from its nape—was of a violet tinge with marked yellow patches. This fish was taken by Captain McLain, of the schooner Herald of the Morning, on Thursday, in latitude 37° 29′ and longitude 74°, some 85 miles from the capes of Virginia. The fish was floating on the surface of the water, belly upward, and was taken by a gaff and

* As will be seen this list includes the names and other important data concerning three vessels which we have not been able to secure elsewhere, and its value is correspondingly great. It enables us to fix more accurately the area covered by the dead fish and also to determine with more definiteness than we otherwise could the limits of time during which this mortality prevailed.

brought on deck. Captain McLain stated that it was alive for three hours after capture. It was the only fish of this kind he had seen, and was a novel fish to him. The captain mentioned, however, that there were other kinds of fish in the water—dead ones—but that he had not thought it worth while to take any, but he said that Capt. W. Gibbs, of the schooner W. H. Oaks, he believed, had picked some up.

"With the New York State fish commissioner, who is always eager to see a new fish, was a representative of the New York Times, and they, after boarding several smacks, found the schooner Oaks, and Captain Gibbs, her skipper, produced the strange fish. Just as soon as this skipper hauled out one of those peculiar cans which the United States Fish Commission provides all captains of smacks with, in order that they shall preserve their specimens, it at once became evident that Captain Gibbs was an ichthyological enthusiast. The captain presented two very queer fish, which looked like a cross between a croaker (*Micropogon undulatus*) and a gurnard. But the difference was marked. The fish had spines, a long bony snout, and a hard, indurated case, so that they would be an exceedingly difficult fish to swallow. In size they were about 10 inches long. The alcohol had bleached them, and of their brilliant coloring there was nothing left but the tail, which was red. It is supposable that they belonged to a deep-sea fish. As it was, they were unknown to the visitors. Captain Gibbs said he saw hundreds of them; they were all dead, and of a brilliant red color. He had sailed for 3 or 4 miles through them. The latitude was 38° 5′, the longitude 73° 40′, and the nearest land, Winter Headquarters, 60 miles off, on the Delaware coast. There were no soundings. The weather was pleasant, nor had there been any blow for some days before. Captain Gibbs handed over his specimens to his visitors with a request that they should be sent to Washington to Professor Baird for examination.

"It seems probable that more specimens of the *Lopholatilus* have been taken on the same day—Thursday, the 20th—by other vessels than the Herald of the Morning, but a careful inquiry among the mackerel schooners at the docks failed to find any more Tile-fish. The Charles R. Lawrence, Captain Carter, may, perhaps, have come across some."*

The fishes brought in by the schooner William S. Oakes, were the *Peristedium miniatum*. This species was first known to science in the fall of 1880, when several specimens were taken in September by the

* The following letter from Mr. Barnet Phillips to Professor Baird, notifying him of the arrival of another specimen of the *Lopholatilus*, was received on the same day that the paragraph quoted above was published:

"I have just seen hanging at Blackford's a Tile-fish of 43 pounds. It was caugh yesterday—Thursday, 20th—by Captain McLain, in latitude 37° 29′, longitude 74°. Name of vessel, schooner Herald of the Morning. Distance from the capes of Virginia, 85 miles where fish was caught. When taken with a gaff it was floating, belly up, and when put on deck lived about two hours.

"I will try and find further particulars as to number of fish seen, &c.

"NEW YORK, *Friday, April* 21, 1882."

United States Fish Commission steamer Fish Hawk while dredging on the slope inside of the Gulf Stream. It was described by Prof. G. Brown Goode, in Vol. 3, Proceedings United States National Museum, 1880.

In 1881, the species was obtained on six different occasions, being taken on muddy or sandy bottom, in depths varying from 69 to 156 fathoms, and in an area between 39° to 40° N. latitude, and 70° to 73° W. longitude. None of these fish have been found elsewhere until picked up dead or in a torpid condition, as believed by some, by the mackerel fishermen off the coast of Delaware and New Jersey.

It is a fact worthy of notice that even as late as the 1st of May many of these fish, remarkable for their brilliant red color, were seen drifting about, and such individuals as were secured were found to be in a perfectly healthy and sound condition.

Capt. Amos Radcliff, of schooner Charles C. Warren, of Gloucester, while engaged in mackerel fishing on the 1st of May, some 30 to 50 miles southeast from Cape May, saw a great number of the *Peristedium* floating upon the surface. He secured several of the fish in a dip net, two of which he preserved in salt. One of these was presented to the United States Fish Commission.

Captain Radcliff says that at the time he saw these fish his vessel was lying to, but from subsequent observations he judged they covered an area of at least 5 miles in diameter. Over all this space they were exceedingly numerous, and a great many of them could be seen all the time the vessel was passing over that distance.

How much longer these fish continued to "turn up" it is difficult to say. As late, however, as the second week in July the writer saw a specimen which had been sent by Capt. I. F. Macomber, of schooner Alice Tarlton, to the editor of the Cape Ann Advertiser, in Gloucester, for identification. The letter that accompanied this fish, and which was published in the Advertiser of July 14, 1882, is quoted in another paragraph where it more properly belongs. No mention is made in it of where the fish was obtained, but presumably it was found floating near or at the same place where Captain Radcliff saw them so plenty, and probably at about the same time.

11.—AREA COVERED BY THE DEAD FISH.

The lack of precision observable in nearly all of the published reports concerning the points where the dead fish were first noticed, and where they were last seen by the several vessels which passed through them, renders the task of determining the area which they covered a somewhat difficult one. In most cases, however, this is not at once apparent, since the localities *seem* to have been carefully given. But a few words of explanation will illustrate this point. We will take, for example, the report of Captain Lamb, of the bark Elizabeth Ostle, which has already been quoted. He says that "on the 21st of March, when about 65

miles off-shore from Barnegat, he sailed for 40 miles through waters filled with these dead fish." * * *

"From my log I find that the exact locality was 39° 07′ N. latitude, and the longitude 73° 10′ W. We had been sailing all the morning north by west, and were well inside of the Gulf Stream."

This may *appear* to be definite, but is exactly the reverse. The question is, what part of his track through the dead fish was the position so exactly given above to mark? Was this observation taken, and the locality noted, when the fish were first seen, when the ship was half way through them, or as she neared their northern boundary and was about to leave them behind her? Of course, it is now impossible to get satisfactory replies to the above questions, and all, therefore, that can be done is to work out the problem as correctly as possible from the data at hand. Captain Lamb throws some light on the subject by saying: "We found these fish when we could not get soundings." As there is a depth of only 35 fathoms at the point where the position he gave (latitude 39° 07′ N., longitude 73° 10′ W.) would place the ship, it seems entirely probable that she was nearing the northern edge of the belt of dead fish when this observation of the vessel's position was made. I have, therefore, laid out the ship's track in accordance with this belief. In considering these questions, however, and in forming conclusions in regard to the tracks made by the different vessels through the floating *Lopholatilus*, I have been enabled, I think, to arrive more nearly at correct conclusions, because of the many reports which have been studied. Thus, the error of one report may be corrected by another, and *vice versa*, until a result is reached which can vary little from absolute exactness.

In consideration of the above I have felt compelled, though reluctantly, to depend to some extent on my own judgment in laying out the various tracks pursued by the different vessels and in estimating the area covered by the dead fish.

The conclusions arrived at have, however, been reached only after mature deliberation and a careful consideration of all the data bearing on this subject, and, though these may appear more or less arbitrary, I trust the explanations given will be sufficient to show that there are good reasons therefor. Following are the names of the vessels that reported the presence of dead fish—at least, those of which we have sufficient information to determine their positions—and a discussion of the probabilities of their sailing on the tracks through the Tile-fish that I have marked on the accompanying plate.

Taken in their chronological order we come first to the bark Plymouth, which sailed through dead fish on March 3, 1882, a distance of 69 miles, from latitude 40° 01′ N. and longitude 69° 51′ W., to latitude 40° 08′ N. and longitude 71° 27′ W., by estimation.

The published account gives no position other than that "we were sailing off the George's Bank." * * * "From 6 o'clock in the

morning until 5 o'clock in the evening we were passing through this school of cod-fish, and as we were sailing at the rate of 6 miles an hour we went through 69 miles of them."

The usual track of sea-going vessels bound from the eastward to New York, and going outside of George's, is about on the parallel of 40° north latitude, and as this is the latitude where Tile-fish have been found most numerous, it is more than probable that the track of the Plymouth was the one indicated on the map. The term "off the George's Bank," as used by sea-faring men, is very indefinite, being commonly employed in the most general sense. It is therefore presumable that the eastern limit of the dead fish seen by the Plymouth's crew was very near that which is given.

On the 10th of March the Rachel Coney, as stated elsewhere, sailed through the floating *Lopholatilus*, a distance of 40 miles while running for the South Shoal light-ship. Her position is given so definitely that it is unnecessary to discuss it.

Four days later (on March 14), the bark Sidon, bound in through the South Channel,* fell in with these dead fish. The account says: "In latitude 40°, longitude 71°, from 1 p. m. until dark they sailed through large numbers of dead fish floating on the water. The weather was cold and stormy, with strong northwest wind."

It is easy enough to decide on the course steered (though no mention is made of this), since the vessel would undoubtedly be heading nearly for the South Shoal light-ship, close-hauled, on the port tack. The difficulty is to decide just how long she sailed through these fish before reaching the position given above. Only one locality being mentioned, it seems probable that this was noted late in the afternoon. If we allow this it will be seen that the vessel's track, for "40 or 50 miles in which she passed through the fish," would be along the edge of the ground where Tile-fish have been caught, and where they were seen by other vessels; indeed, its northern end crosses the track of the Plymouth, while its entire length is nearly parallel with the northeastern end of the route through the dead fish made by the Navarino eight days later.

The next day (March 15) after the floating fish were seen by the crew of the Sidon, Captain Rich sailed through them a distance of 50 miles, on a west by south course, from latitude 40° N. and longitude 70° W., to latitude 39° 43′ N. and longitude 71° W. He gives his positions with exactness—the only one to do so—and this is of very great assistance in determining the routes sailed over by other vessels passing near the same locality.

* The broad channel between Nantucket Shoals and those on George's Bank is called the "South Channel." Vessels coming from the south, especially from the West Indies, as this one was, and bound to ports in Northern New England, usually pass through this channel, and, if practicable, shape their course so as to pass outside, but within sight of, the light-ship on the South Shoal of Nantucket.

But it was in the period from March 20 to 25 that the dead fish seem to have covered the largest area, and during this time the reports of their having been seen were more frequent than before or afterwards.

The ship British America is reported to have seen the dead fish on March 20, 45 miles south of Shinnecock, Long Island, which would place her in latitude 40° 05′ N., longitude 72° 24′ W. No mention is made of this ship having sailed through the dead fish for any distance, or, indeed, is any information given other than that the fish were seen in the locality named. The correctness of this even is open to a doubt, for it seems extremely probable that the dead fish were not so far north, since the position given is some 25 to 30 miles, at least, inside of where the Tile-fish might have been expected to occur. It is possible, however, that some unknown circumstance may have caused them to venture into waters of less depth than they had previously been found in, or they may have been carried by the wind and waves a long distance from the place where they first came to the surface.

On the same day (March 20) the steamship Beila reported seeing dead fish 60 miles south of Barnegat, which would be in latitude 38° 46′ N., longitude 73° 56′ W. The same may be said of the Beila as of the ship British America. The position given is far inside of where the fish were seen by other vessels, and in shallow water. Nothing is said of her passing through the dead fish for any distance, though she probably did, and in the absence of other data we can only submit such as are available.

March 21 the bark Elizabeth Ostle sailed through the dead fish from latitude 38° 37′ N., longitude 72° 58′ W., to latitude 39° 15′ N., and longitude 73° 15′ W.

On the same day the schooner Navarino, bound north, struck the dead fish in latitude 38° 41′ N., longitude 73° 01′ W., near the same point where they were first seen by the crew of the Elizabeth Ostle.* Running on a northeasterly course along the edge of soundings inside of the Gulf Stream, *the Navarino plowed her way through the dead fish from the* 21st *until night of the* 22d, *a distance of* 150 *miles, to latitude* 40° 17′ *N. and longitude* 70° 30′ *W., crossing the tracks of the Elizabeth Ostle, Alf, Avonmore, and Plymouth, and for* 40 *or* 50 *miles toward the northern end of her track, sailing nearly parallel with the course which the Sidon made through the Lopholatilus eight days before.*

On March 22 the bark Alf sailed through the dead fish from latitude 38° 37′ N., longitude 72° 54′ W. to latitude 39° 32′ N., and longitude 72° 26′ W., a distance of 60 miles. The account of the course sailed by the Alf is so indefinite that we can only guess at it. Captain Larsen says: "When just inside the Gulf stream, about 70 miles south-

* These vessels were sailing nearly at right angles to each other, and though the data are indefinite and unsatisfactory, they are, nevertheless, sufficient to arrive pretty closely at the positions where the dead fish were first observed and where they were last seen.

southeast from Sandy Hook, I saw for 60 miles, scattered over the water, thousands of dead and dying fish. This was in about 15 fathoms of water." Like nearly all the other statements we have, there is only one position given, but from the context and from a consideration of other data, we are able to estimate the probable course he made. The wind permitting, the bark would, of course, be sailing direct for New York, whither she was bound; otherwise, she would be steering close-hauled on a wind on whichever tack she could lay nearest to her course. Mr. Wilcox writes that the Navarino reported having a strong northwest wind, and it must have been on March 22 that this wind prevailed, for on the 21st the bark Elizabeth Ostle, in or near the same place as the Navarino, was on that day steered north by west, a course which it would be impossible for her to make with a northwest wind. With the wind at northwest, blowing a strong breeze, the Alf would, in all probability, be close-hauled on the port tack, heading along about N.NE., and, allowing for leeway, would be making a course about NE. by N.½ N. Admitting this—and there seems no reason to question it—the next thing is to determine where the fish were first seen. Captain Larsen says, "just inside the Gulf Stream, about 70 miles S.SE. *from* Sandy Hook." Now, as the position, "70 miles S.SE. *off* Sandy Hook," *is not just inside the Gulf Stream*, but about 115 miles from it, or nearly two-thirds the distance from it to New York, and as the captain of the Elizabeth Ostle found the dead fish on the previous day off soundings, though he called his position 65 miles from land—an evident error—we are compelled to believe that the Alf met with the dead fish near the same place where they were first seen by the crews of the Elizabeth Ostle and Navarino. It is probable that the northwest wind had driven the body of floating Tile-fish slightly from the position they occupied on the 21st, and that the Alf fell in with them a little to the southeast of where they were first encountered by the Elizabeth Ostle. Crossing the track of the Navarino at an acute angle the Alf stood on, gradually drawing on to soundings, and probably ran out of the fish a few miles northwest of where their inner edge was observed by the captain of the Avonmore three days later, at which time they had, without doubt, been driven somewhat to the southeast by the prevailing northwest winds.

As to the Alf sailing for 60 miles in 15 fathoms of water, it is enough to say that it is simply out of the question, since, if this were so, she would have been standing along the New Jersey coast, in sight of the land, and if such had been the fact it would doubtless have been mentioned.

For the reasons given above, it is probable that the track of the Alf, as laid down on the plate, is nearly the correct one.

March 25, bark Avonmore passed through dead fish from lat. 39° 15½′ N., long. 72° 03′ W., to lat. 39° 28′ N., and long. 72° 23′ W.

April 20, a floating Tile-fish was seen and captured by Captain

McClain, of the schooner Herald of the Morning, in lat. 37° 29′ N., long. 74° 00′ W.

About the same time dead fish were seen floating at the surface by the crew of schooner William S. Oakes, 40 miles in a northeasterly direction from where the specimen was obtained by the Herald of the Morning, and several individuals, as has been mentioned, were picked up in lat. 38° 05′ N., long. 73° 40′ W.

About the 1st of May dead fish of the species *Peristedium* were seen off Cape May, about from 15 to 30 miles southeast from Five Fathom Bank Light-Ship, by the crew of the fishing schooner C. C. Warren.*

Throwing aside for the present the consideration of the reports of those vessels which saw the dead fish in April, or later, we will proceed to consider the area which was covered in March, estimating this from such data as has been discussed.

The approximate length of 150 miles we get from the distance sailed by the Navarino, but if we consider the report of the Beila, this must be increased at least 20 miles, making a total length of 170 miles. The average width can be no less than 25 miles, and multiplying these together we find that the enormous expanse of 4,250 geographical square miles, or 5,620 square statute miles, was covered with a mass of dead and dying fish. If to this is added the area farther south, which was probably covered more or less thickly by floating *Lopholatilus*, a short time later (if not at the same time), as indicated by the specimens and reports brought in by the fishing schooners, we find that our estimate must be increased nearly a half more and would reach the sum of about 7,500 square statute miles.

In making these estimates I have thought best to keep them down to the minimum, so as to be within rather than outside of the probabilities, and have therefore not considered the reports of the ships British America and Beila in connection with the width of the estimated area. Neither do I think it desirable to take into account the possible area covered near the place where the fish were seen by the Herald of the Morning and the William S. Oakes. A bare allusion to the matter seems sufficient. In estimating the width of the sea area over which the Tile-fish were seen floating, I have thought best to make it about two-thirds as much as the several reports would indicate, thus allowing for any possible exaggeration—though all could not err in this particular—and the drift or spreading out of the fish after coming to the surface.

12.—PROBABLE NUMBERS OF DEAD FISH.

The question which is most naturally suggested to the mind when considering the immense area over which the Tile-fish were found is,

* The statements I have been able to obtain as to the exact locality in which these fish were seen by the crew of the C. C. Warren are not sufficiently definite to warrant me in giving the position in any other than a general way.

how many of these dead or helpless fish were there floating upon the ocean's surface?

We are aided somewhat in making the estimate by the reports of the several captains. Captain Jorgensen says they were "only *scattering*, sometimes as many as twenty being seen at a time near the vessel." Captain Lawrence remarks: "All around us, and for miles back of us, was filled with these fish." Captain Rich is more explicit. He writes: "Sometimes there would be only two or three in sight, and at others thirty or forty of them." Captain Lamb saw them more abundant than any one else, and estimates that in a space as large as his cabin there would be fifty fish. As the cabin would in all probability not be, at the most, more than 18 feet long by 15 wide, or about a square rod in area, this gives us a fair basis for making an estimate, but it seems that we ought to base our calculations on a much smaller number than was seen by Captain Lamb. That the fish were exceedingly abundant and literally covered the seas over a large part of the area where they were seen is altogether probable. Mr. A. R. Crittenden, who has had unusual opportunities for conversing with the captains who saw these dead fish, tells me that they all say that, while in some places the fish were comparatively scattering, for the most part they were so thick on the water that the vessels, as they sailed along, turned from either side of their bows "windrows of floating *Lopholatilus*."

Taking as a starting point the estimate of Captain Lamb, and calculating that the fish averaged in abundance one-twentieth what he reported their numbers to be, we find that there would be 256,000 in a square mile, and the astounding total of 1,438,720,000 fish drifting about on this part of the ocean in a dead or benumbed condition. Now, placing the average of these fish at 10 pounds, which is a little less than the average weight of Tile-fish, we get 14,387,200,000 pounds, or about 288 pounds of fish to each of the 50,000,000 of inhabitants of the United States. The enormous magnitude of these figures, and the extreme abundance of animal life on the unexplored grounds lying inside of the Gulf Stream, can only be comprehended, when we consider that if we reduce this still further, even dividing it by 200, and thus practically allowing that only one fish was seen where Captain Lamb said there were *four thousand*, we still find that the mass would rival in weight the product of some of our most important and valuable food fisheries. Taking all the concurrent testimony, however, it seems hardly necessary to make so low an estimate, and it appears reasonable that to place it at one four-hundreth of that of Captain Lamb, is, perhaps, putting it quite low enough. This would give the sum of 719,360,000 pounds of dead fish, and if we were to calculate on the same basis the probable numbers which were floating south of the area that has been considered, that is, down to the point where the Herald of the Morning was, this amount must be increased nearly one-half, or to about 1,000,000,000 pounds, in round numbers.

13.—SPECIES OF DEAD FISH OTHER THAN THE LOPHOLATILUS.

That there were more or less dead fish of species other than the *Lopholatilus* is unquestionable, though, from all the data we have at hand, it is evident that the greater part of these millions of floating fish were of one kind, and that of the species which forms the subject of this paper. Nearly all of the observers agree in saying that there were several kinds of fish, and especial mention is made of one having a brilliant red color, considerable numbers of which were seen scattered about among the larger forms. Fortunately, specimens of this red fish were obtained, and it has been definitely settled that they belong to the species *Peristedium miniatum*. Just what proportion of the floating masses this species represented can only be conjectured, but as it is a small fish and has been generally spoken of as if it was seen only occasionally or scatteringly, it seems probable that it formed only a small percentage of the great mass. Many of the captains thought that the fish they saw were cod, and the captain and crew of the Navarino, writes Mr. Wilcox, "were quite sure a small portion of the largest were *cod* and *hake*."

The following clipping, evidently from the Boston Herald, date not given, was sent to Professor Baird by Capt. S. J. Martin, and contains essentially the same facts as those quoted from Mr. Wilcox: "The schooners Navarino and L. R. Story report sailing through large quantities of dead fish for a distance of about 150 miles, first striking them in north lat. 38° 40′′ and about 72½° west long. Captain Foss, of the L. R. Story, reports the fish to consist of fully *one-third part codfish and hake, the balance being of the new variety, christened by Professor Baird as Tile-fish.* Many of the codfish were very large, measuring from 4 to 5 feet in length."

This may have been so, but is open to a doubt; first, because the seamen employed exclusively in the merchant service have only the most general knowledge of the different kinds of fish, and are scarcely able to tell one from another, as may be observed by reading the accounts which have been quoted; second, Captain Rich, who I understand is a Cape Cod man by birth, and very possibly has been a fisherman at some period of his life, quickly detected the difference between the Tile-fish and the cod, and, writing to Professor Baird, he says: "I see several vessels have passed through them as codfish, but they are different from the ordinary codfish." Nor does he mention seeing the "ordinary codfish," though it is scarcely probable that so close an observer would forget to call attention to the fact if he had noticed any of the *Gadidæ*, all of which are so well known to any of the New England fishermen. That he would have done so is all the more probable, since he says, when writing of the Tile-fish "When first seen there were a few redfish [*Peristedium*] with them, but when we lowered the boat there was nothing but the Tile-fish in sight."

From the descriptions given the fish seen by the crews of the Elizabeth Ostle and the Avonmore were undoubtedly all Tile-fish; at least no others are mentioned, and it is probable that the "Nova Scotia man," spoken of as one of the crew of the Elizabeth Ostle, would have quickly noticed the presence of cod or any of the other species of the *Gadidæ*.

But Captain Larsen, after speaking particularly of the *Lopholatilus* and the *Peristedium* (for from his description these were the fish he saw with few exceptions), says: "Besides these there were large, flat, brown-looking fishes and thousands of small fishes, shiny in color, about a foot long." As to the species to which these last two mentioned kinds belong it is useless to conjecture, and we must therefore leave it as one of the unsolved problems of this most wonderful phenomenon.

14.—THEORIES ADVANCED AS TO THE CAUSE OF THE MORTALITY.

Were these millions of fish dead, or were they only in a torpid condition, with their vital functions temporarily suspended?* If dead, what was the cause of this wholesale, this astounding destruction? If not dead, but only benumbed, to what shall we ascribe the phenomenon? These are the questions which most naturally arise in the mind when studying the various phases of this singular appearance of millions of fish floating on the sea, and it is not at all strange that many and varied theories have been advanced to account for the strange occurrence. From the very nature of the case we cannot arrive at any definite conclusions as to the facts, and must therefore, for the present, at least, content ourselves with conjecture. Nothing further, therefore, will be attempted here than to present the several theories which have been advanced, and to discuss in as impartial a manner as possible the probability of their correctness.

The generally received opinion in regard to the floating fish was that they were dead, but this was not the belief of all, as is shown by the following letter published in the Cape Ann Advertiser of July 14, 1882, previously referred to, and with which was sent to the editors of that paper a specimen of the *Peristedium*, one of the "small fish" alluded to in the letter, and which I saw:

"*Messrs. Editors:*

"The large quantities of fish found floating last fall and winter between Cape Hatteras and New York were reported as dead. I fell in with many of both last fall† and this spring, and had the curiosity to examine them, and found that they were not dead, but apparently blind, having air bubbles inside of the outer covering of their eyes. On taking them

* In the account of the cruise of investigation in the smack Josie Reeves, which is appended to this paper, it will be seen that there is strong presumptive evidence that most if not all of the floating fish were dead, or finally died.

† The allusion made here to fish having been found the previous fall is an evident error, for no other statement to that effect has been received.

on board and laying them on deck in the warm sun, four out of five partially recovered and moved. Among those seen last year were hake, and I have heard of cod being seen. Some of the small fish had so much life that they would dart away a few feet on being disturbed. One of the number I secured, which I have preserved and forward to you. Please interest yourselves in finding out the name and class it belongs to and let me know. The color of the fish when taken was red.

"Yours, very truly,

"I. F. MACOMBER,

"*Schooner Alice Tarlton.*"*

Captain Coney, of the brig Rachel Coney, says that most of the floating fish he saw were not dead, but apparently benumbed or "loggy," as he expresses it. He thought their condition was owing, perhaps, to a lack of food, for he found nothing whatever in the stomachs of a dozen or more of the fish which he opened.

Captain McLain, of the schooner Herald of the Morning, says that the Tile-fish that he secured, and which was the only one he saw, was apparently alive when taken from the water, and retained its muscular activity in a most wonderful manner for quite three hours, so that, even after being eviscerated and placed on ice, the involuntary action of the muscles caused it to move to such an extent that it fell out of the pen onto the ice-house floor.

Other observers noticed that at least some of the fish had the appearance of being alive, though as previously stated, the general opinion seems to have been that the majority were dead. Undoubtedly this last-mentioned opinion was correct, and it seems highly probable that few indeed of these millions of floating fish ever regained sufficient strength to enable them to return to their usual haunts, even supposing they were not all dead when seen.

But whether the fish were dead or only temporarily disabled, their appearance upon the surface of the water in such extraordinary numbers is unquestionably due to some special cause, and probably only

*The mention of "air bubbles inside of the outer covering of their eyes" is a feature worthy of notice in this connection, since a similar appearance is often noticeable in some of the *Gadidæ*, especially the cusk (*Brosmius americanus*) when caught on a trawl. Though the fish are rarely dead when they come to the surface of the water, their eyes seem forced nearly out of their heads and are filled with air bubbles, while their stomachs are usually turned inside out and distended to their utmost extent with air. The fish are said to be "poke blown," and, though still retaining considerable activity and muscular motion, it is extremely doubtful if they are ever able to regain sufficient strength to enable them to return to their normal condition. I deem this all the more improbable, since I have often seen fish drifting about on the surface of the sea which had broken loose from a trawl, and which, notwithstanding repeated exertions and flappings of their tails were totally unable to recover themselves sufficiently to get underneath the water, or to prevent themselves from floating belly up. Undoubtedly, in nearly all such cases, the fish, if still "lively" when they first came up, have evidently died because of the unnatural position in which they were compelled to remain.

one. But we cannot positively determine whether this phenomenon was due to a sudden fall of temperature of the sea, a submarine volcanic action, a lack of food, or some other of the many possible causes assigned by different theorists. Therefore the best that can be done is to consider, in their various bearings, the several theories which have been advanced as the cause of this mortality.

The theory that perhaps was most generally advanced by those who studied the subject was that these fish (quite possibly at that time just approaching the coast) met with a stratum of unusually cold water, which paralyzed and rendered them helpless to such an extent that they floated to the surface of the sea dead or in a dying condition. The furious northerly gales which swept the region where the dead fish were seen, and many hundreds of miles farther north, about the last of February or first of March, may have caused, as was thought by some, an unprecedented low temperature in the sea water in that locality. No doubt the prevalence of these winds at the time mentioned may have had much influence in changing the temperature of that part of the ocean, but if there was any material and unprecedented difference in this respect, it seems more than probable that it was caused chiefly by the unusual accumulation of ice on the eastern fishing banks off the coast of Newfoundland and along the southern shores of Nova Scotia. Many of the Gloucester fishermen, who visit these localities year after year, agree in saying that never before have they seen such a large quantity of drift-ice on the coast of Nova Scotia; neither have they known of its being so far to the southwest. There can be no question as to the influence exerted by this vast body of ice on the surrounding sea, and it seems reasonable to suppose that the polar current, flowing to the southwest, inside of the Gulf Stream, may have carried this cold water to an unusual distance, accelerated, as it undoubtedly was, by the force of heavy northerly gales. The statement of Captain Lawrence, who seems to have been impressed with this idea, is corroborative of the above. He says: "The current known as the polar current is now [in March, 1883] running very strong. It's not unlikely that the icebergs grounded off the banks may have made the water so cold that they [the Tile-fish] couldn't stand it." Captain Rich, too, ascribes the death of the Tile-fish to excessive cold. It is a well-known fact that an extraordinary amount of cold will cause even the hardiest of fish to float dead and helpless upon the surface of the water in the same manner as the Tile-fish were seen. We know that even the codfish, a species which can endure the cold of the northern seas, when confined in the well of a smack and suddenly brought in contact with very cold water, will quickly die and float, belly up, at the surface. This is often observable in Fulton Market slip, New York, in winter, when the smacks, coming in from the fishing grounds with a load of live codfish, meet with floating ice in the harbor; at such times the fish will all be either dead or helpless in a few minutes.

I have been told by fishermen that they have seen large numbers of cod floating upon the surface of the water on the coast of Labrador, when several icebergs, drifting into a small bay, has caused a very decided and sudden fall in the temperature of the water. Such fish as were in the bay would soon become entirely helpless, and drift whichever way the winds or currents carried them, unless, indeed, as was often the case, many of them were picked up and carried on board of the vessels by the fishermen. Captain Kirby says that on one occasion, when he was at Cape Charles Harbor, on the coast of Labrador, about the 1st of August, 1876, he saw an immense number of codfish floating at the surface of the water, and spreading over an area of at least from 4 to 6 square miles. More than 300 quintals were picked up and cured by the local fishermen. At the time these fish were seen an unusual number of icebergs were grounded in the vicinity. As many as seven or eight large bergs were within an area of 4 or 5 miles, "while," says Captain Kirby, "we counted forty bergs one day while standing on the hills of Cape Charles."

The fishermen were of the opinion that the excessive coldness of the water, caused by the proximity of so much ice, had killed the fish, and no doubt they were right.

A similar phenomenon has been observed on the coast of Northern Europe, which also occurred to the *Gadidæ*. Though no special cause is assigned, it may be, and possibly was, due to some sudden change in temperature. In a letter addressed to Sir John Sinclair, cited by Milner in his Gallery of Nature, the statement occurs that on the 4th of December, 1789, the ship Brothers arrived at Leith from Archangel, and its captain reported "that on the coast of Lapland and Norway he sailed many leagues through immense quantities of dead haddocks," and "he spoke several English ships which reported the same fact." It is also stated by the writer that haddock, which was the fish in greatest abundance in the Edinburgh market, was scarcely seen for three years.

The following letter from Brigadier-General R. B. Marly, U. S. A., to Professor Baird is of very great interest in this connection, showing, as it does, how the destruction of great multitudes of fish, as well as other marine animals, may occur in the southern waters by reason of a sudden change of temperature, caused only by the prevalence of strong northerly winds, such as we have noticed as occurring about the time when the Tile-fish were seen.

"MY DEAR PROFESSOR: On reading a brief account of the fish that were recently seen floating upon the surface of the ocean near the Gulf Stream in a torpid or dead condition, and which I have not seen accounted for, it occurred to me that I could throw some light upon the subject, which the following facts within my own observation will show:

"You will remember that our troops under General Taylor passed the winter of 1845–'46 at Corpus Christi, Tex., and while there we one

night were visited with a pretty heavy frost, which seldom ever occurred in that locality, and, much to our astonishment, the beach in the vicinity of our camp on the following morning was thickly strewn with fish and green turtles that had floated up from the gulf. The fish were perfectly torpid, and the turtles, upon their backs, perfectly paralyzed, so that we picked up many wagon-loads, sufficient to feed the entire army.

"It is a well-known fact that neither men nor animals can endure any great degree of cold in that latitude and climate, for it is not uncommon for both to perish when exposed to the piercing 'northers' which sweep over those prairies, notwithstanding the thermometer rarely falls to the freezing point. I lost thirty-five mules out of a herd of one hundred and ten in one of these rain-storms during a single night. They laid down and died while they were in good flesh.

"The fact is that all animal life seems unable to endure any great change of temperature in that climate, and I therefore am of opinion that the fish observed floating upon the surface near the Gulf Stream perished from encountering the sudden change of temperature in passing from the warm water to the unusually severe cold water outside the stream.

"Moreover, those fish may have been carried by the current from the Gulf of Mexico to the much higher northern locality where they were observed.

"It appears by one statement that several varieties of fish were seen, but if only one kind was noticed that particular kind may have been more sensitive to the change of temperature than others.

"Your statements that the fish were perfectly fresh and free from apparent disease, with merely the vital function suspended, would go to corroborate my views, as our fish at Corpus Christi were in a similar state.

"NEW YORK HOTEL,
" *Washington, April* 2, 1882."

Since the foregoing was written the following interesting paper relative to this subject from the pen of Prof. A. E. Verrill, of Yale College, has been published in the New York Times of October 29, 1882. Professor Verrill, having been connected with all the researches made in this locality by the United States Fish Commission, under the direction of Professor Baird, is unquestionably one of the best authorities that can be cited, and I take pleasure in quoting extensively from this article, since it throws light on many points which have not been considered in the preceding sections of this paper. He writes:

"In the autumn of 1880 the United States Fish Commission commenced the exploration of the sea bottom along the edge of the Gulf Stream, about 90 to 110 miles off the south coast of New England. The results then obtained were so interesting and important, and the discoveries of new forms of life were so unexpectedly numerous and

remarkable, that similar explorations were continued in 1881, and again during the past season. This year and last Prof. S. F. Baird, the United States Commissioner of Fish and Fisheries, established the headquarters of the Commission at Wood's Holl, Mass. This place will hereafter be made a permanent station of the Fish Commission. Owing to the unusual delay of the Government appropriations our work was delayed this year about a month in the best part of the season, for we could not begin dredging until August. Unfavorable weather and other causes afterward prevented us from making more than five trips to the Gulf Stream slope this season, but these were very successful.

"Our dredgings in this region now cover a belt about 160 miles long east and west and about 10 to 25 miles wide. The depths are mostly between 70 and 700 fathoms. The total number of successful hauls made along this belt is now about one hundred and twelve. These have nearly all been made with our large improved trawls; a few have been made with a large rake dredge. At all localities the temperature of the water, both at the bottom and surface, was taken, as well as that of the air. In many cases series of temperatures at various depths were also taken, and other physical observations made and recorded. Lists of the animals from each haul have been made with care and arranged in tables. In this region the bottom slopes very gradually from the shore to near the 100-fathom line, which is situated from 80 to 100 miles from the mainland. This broad, shallow belt forms, therefore, a nearly level plateau with a gentle slope seaward. Beyond the 100-fathom line the bottom descends rapidly to more than 1,200 fathoms into the great ocean basin, thus forming a rapidly sloping bank as steep as the side of a mountain and about as high as Mount Washington, New Hampshire. This we call the "Gulf Stream slope," because it determines practically the inner border of the Gulf Stream all along our coast from Cape Hatteras to Nova Scotia. In our explorations a change of locality of less than 10 miles would often make a difference of more than 3,500 feet in depth on this slope. The upper part of the slope and the outermost portion of the adjacent plateau, in 65 to 150 fathoms, is bathed by the waters of the Gulf Stream, and consequently the temperature of the bottom water along this portion is decidedly higher than it is along the shallower part of the plateau nearer the shore. Moreover, the Gulf Stream itself is limited in depth to about 150 fathoms or often less, and below this the temperature steadily decreases to the bottom of the ocean basin. We may therefore properly call the upper part of the slope in 65 to 150 fathoms the "warm belt." Our observations give the bottom temperature of this warm belt as usually between 48° and 50° Fahrenheit. On this belt we took numerous kinds of animals that were previously known only from the Gulf of Mexico or off Florida. Some of them belong to tribes that have always been considered as tropical, or subtropical, such as *Dolium*, *Marginella*, and *Avicula* among the shells. In fact this belt is occupied by a northern

continuation of the southern or West Indian Gulf Stream fauna. On the lower part of the slope, in 150 to 780 fathoms, we find numerous Arctic forms of life, corresponding to the lower temperature which, in 300 to 500 fathoms, is usually 40° to 41° Fahrenheit. On the inshore plateau, which is occupied by a branch of the cold Arctic current, we also find Arctic species of animals. Probably no other equally large part of the ocean basin in similar depths has been so fully examined as this region. * * *

"Probably the total number of species of animals already obtained by us is not less than 800. The number already identified or described and entered on our lists of the fauna of this belt is about 650. This number includes neither the Foraminifera nor the Entomostraca, which are numerous, and but few of the sponges. Of this list less than one-half were known on our coast before 1880, and a large number were entirely unknown to science. Of fishes there are perhaps 70 species. Of the whole number already determined about 265 are Mollusca, including 14 Cephalopoda; 85 are Crustacea, 60 are Echinodermata, 35 are Anthozoa, 65 are Annelida.

"Although the Tile-fish remained unknown, both to naturalists and fishermen, until three years ago, it has already become somewhat famous. One of these fish was sent to Messrs. Goode and Bean, of the United States Fish Commission, for examination. It proved to be a remarkable new species, belonging to a new genus, and they immediately named and described it. The fish is bright colored, and covered with round, golden-yellow specks. Large ones are over 3 feet long and may weigh 40 to 50 pounds. In 1880 and 1881 the Fish Commission endeavored to test the abundance and range of this fish and also its edible qualities. It was taken by our steamer on several occasions during these two years by means of a long trawl-line, at different localities, many miles apart, along the warm belt of the Gulf Stream slope in 100 to 130 fathoms. Therefore it is doubtless a southern species, and will hereafter probably be found off our southern coast, or even in the Gulf of Mexico, at suitable depths. On one occasion, in 1881, we took 80 of these fishes, weighing 500 pounds, at one haul. The fish, after a satisfactory trial by many competent judges, was proved to be a valuable food-fish.

"After a severe storm last winter many vessels reported seeing great quantities of dead fishes of a strange kind floating at the surface of the sea in the same region where the Tile-fish had been discovered. These dead fishes were perfectly fresh and wholesome, without any appearance of disease or violence. Many of them were eaten. Some were sent to Washington for identification, and they proved to be Tile-fish. The dead fishes were reported as occurring abundantly over a large area—perhaps 5,000 square miles or more. There must have been millions of pounds wasted. It became, therefore, a matter of great interest and importance for the Fish Commission to ascertain during the

past season whether the Tile-fish had been nearly or entirely exterminated in this region, and if so, to investigate the cause.

"One of the most peculiar facts connected with our dredgings along the warm belt this season was the scarcity or total absence of many of the species, especially of Crustacea, that were taken in the two previous seasons, in essentially the same localities and depths, in vast numbers—several thousands at a time—and in many localities. Among such species were some peculiar small spider-crabs, hermit-crabs, and shrimp (*Euprognatha*, *Catapagurus*, and *Pontophilus*); also, curious small lobster-like creatures (*Munida*). The latter was one of the most abundant of all the Crustacea last year, but was not seen at all this season, with the exception of a single example on the last trip; the others were taken only in small numbers. Two attempts were made to catch the "Tile-fish" (*Lopholatilus*) by means of a long trawl-line on essentially the same ground where eighty were caught in one trial last year. On the last occasion this year the trawl-line used was about 2 miles long, with over two thousand hooks. Both of these attempts resulted in a total failure.

"In order to test the question of the disappearance of the Tile-fish more fully Professor Baird employed in September, a fishing-vessel, the Josie Reeves, to go to the grounds and fish systematically for the Tile-fish by using long trawl-lines, such as had proved successful last year in our trials. On her first trip, ending September 25, she fished three days in several localities at the proper depths and on the right kind of bottom, but did not catch a single Tile-fish.

"It is probable, therefore, that the finding of vast numbers of dead Tile-fish floating at the surface in this region last winter was connected with a wholesale destruction of the life at the bottom, along the shallower part of this belt, (in 70 to 150 fathoms,) where the southern forms of life and higher temperatures (47° to 52°) are found. This great destruction of life was probably caused by a very severe storm that occurred in the region at that time, which, by agitating the bottom water, forced outward the very cold water that, even in summer, occupies the wide area of shallower sea, in less than 60 fathoms, along the coast, and thus caused a sudden lowering of the temperature along this narrow warm zone, where the Tile-fish and the Crustacea referred to were formerly found.

"The warm belt is here narrow, even in summer, and is not only bordered on its inner edge, but is also underlaid in deeper water by much colder water. In fact, the bottom water further inshore is probably below 32° Fahrenheit in winter where the depth is 20 to 40 fathoms. In August, this year, we found the temperature 37° Fahrenheit, south of Cape Cod, in 55 to 60 fathoms. It is evident, therefore, that even a moderate agitation and mixing up of the warm and cold water might, in winter, reduce the temperature so much as to practically obliterate the warm belt at the bottom. But a severe storm, such as

the one referred to, might even cause such a variation in the position and direction of the tidal and other currents as to cause a direct flow of the cold inshore waters, to temporarily occupy the warm area, pushing further outward the Gulf Stream water. The result would, in either case, be a sudden and great reduction of the temperature, perhaps as much as 15° to 20°.* This could not fail to be very destructive to such southern species as find here nearly their extreme northern limits.

"It is probable, however, that these southern species, including the Tile-fish, were not thus destroyed further south. Therefore it is probable that in a few years they will again occupy these grounds by migrating northward, even if there be not enough left here to replenish their races."

While, as we have seen, there was apparently good reason in the opinion of many well-informed gentlemen to suppose the mortality among the Tile-fish was caused by cold water, there were others who, perhaps, were quite as firm in the belief that it was not cold, but unusually warm water which had destroyed the *Lopholatilus.*

The idea of the fish having been killed by coming in contact with the Gulf Stream seems, however, to have soon been abandoned, if we may judge by the following facetious allusion to it in the New York Times of April 22, 1882:

"Theories are still rife as to the reasons for the killing of these fish. The Gulf Stream notion, of the fish getting into hot water, not having a leg or a fin to stand on, others are now being ventilated. Said one wise skipper, 'There has been convulsions of nature under the seas. Now, you see, mates, these here loaferlatter lushisses is deep-sea fish. There comes the deuce to pay down below—their bladders gets busted, and up they comes like balloons. That's a pint no fish-sharp has studied up yet; don't you see?'"

In the Times of March 26, 1882, the theory of the fish having been destroyed by some sort of submarine volcanic action was advanced as follows: "Such an apparent wholesale destruction could only have arisen from some great natural cataclysm. In Southern waters, some years ago, a vast number of fish were found dead floating on the water. Studying the causes for this wholesale destruction, it was quite conclusively shown that there had been some volcanic eruption, which had taken place at the bottom of the sea, as a considerable quantity of a porous

* As I have previously stated, the fall in temperature, if such occurred, was probably due to an acceleration of the speed of the Arctic current, together with a presumable lowering of its temperature by the masses of ice off the Banks and Nova Scotia, This seems more plausible than to suppose that a commotion of the surface water might affect the greater depths. Were this possible it is to be assumed that the temperature of this region might undergo similar sudden changes of temperature each winter, since, as is well known, heavy northerly gales—as strong as those of February and March, 1882—are occurring every week or two, from November to April, in each year. Therefore, were this so, the Tile-fish would have scarcely existed in this locality long enough to have become so numerous as they were found in 1879-'80, and especially to reach an abundance such as was shown by the floating millions of March and April, 1882.

substance rose to the surface which was apparently composed of earthy matter, showing signs of having been heated or fluxed."

Mr. George E. Emory held the same opinion, and seemingly not aware that such a theory had been previously advanced, writes as follows in the Boston Daily Advertiser of April 5, 1882:

"I conclude these fish were not destroyed by any of the agencies lately suggested. Those floating thousands seen only represent the myriads left untouched by the local disaster and destruction. Probably a submarine disturbance of a volcanic character, set free mephitic gases which, reaching the fishes, produced a fatal asphyxia. This sort of fish-killing agency has been observed repeatedly in the vicinity of volcanic islands, as about Iceland and many other localities. A line of volcanic *stress* extends from Mount Erebus far below Terra del Fuego, through sea and land, away northwardly to the Aleutian Islands and the regions southward from Behring Strait. This line is intersected in Mexico by another line of pressure, extending away beneath the Atlantic Ocean to the Azores, thence to Franz-Josef Land, northeastward of Spitzbergen. Here is the old volcano of St. Thomas, now inactive, but known well in the fourteenth century. Tracing southwardly, we find the volcano Esk on Jan Mayen Island, and farther south is Hecla, in Iceland. At the west of the outer Hebrides the Rokol cliff and shoals are the remains of a great volcanic island, partly destroyed by an eruption in 1446. Thus extends the volcanic line of the Atlantic, and over a large part of the sea bottom along this line the mud is full of volcanic ashes. Deep-sea dredging has demonstrated the reality of the vast ash deposit."

This may have been the correct theory, but there were no reports of phenomena, which would lead us to suppose there had been anything like a submarine volcanic eruption near the locality where the Tile-fish were seen.

The following paragraph, which was extensively copied in the press, was thought by some to offer a possible solution of the problem, and to strengthen the position of those who had advanced the opinion that the fish mortality was due to volcanic action:

"BALTIMORE, *April* 17, 1882.

"Capt. G. H. C. Horner, of the German ship Stella, which arrived last Saturday from Bremen, gives an account of a singular phenomenon which he witnessed while on the way to this port. On the morning of March 18, Chief Officer Deboer had charge of the morning watch. The weather was serene and clear and the sea smooth and calm. The ship was going along at a rate of 2 miles an hour by the wind. At about 5.30 o'clock the vessel suddenly halted in her course, quivering from keel to keelson, and conveying the impression to those below that the ship had struck a rock. Captain Horner, who was below, looking over his chart, at once ran on deck to ascertain the cause of the shock, and, finding the weather clear and the sea tranquil, was puzzled. Neither the chief mate, who was on the quarter-deck at the time, nor the look-

out could account for the strange occurrence. The captain then ordered the heaving of the lead, but found no bottom at 100 fathoms. The pumps were sounded and the ship found to be tight. The shock lasted only half a minute, after which the ship went on as before. Captain Horner himself went aloft, but could discover no signs of any obstructions. He expresses the opinion that he had encountered a tremor or submarine volcanic eruption. The ship's position at the time was in latitude 37° 21′ north, longitude 23° 51′ west. He found the rate of the chronometer correct, observation being taken 56 minutes after the shock."

By reading the above extract carefully it will be seen that the Stella (if the account given is correct), was more than 2,000 nautical miles to the eastward of where the dead fish were seen, and it is scarcely reasonable to suppose that any influence could have been exerted on animal life even at one-tenth of that distance. Another thing which should not be lost sight of is, that the Tile-fish were seen floating at sea by the crew of the bark Plymouth on the 3d of March, fifteen days before the Stella received the shock which has been mentioned, and several other vessels also reported seeing dead fish previous to the 18th of March. It will therefore be seen that, even had this supposed volcanic eruption taken place much nearer the locality where the dead fish were noticed than it did, it could not be called the original cause of their destruction.

Then, too, if the mortality was due to volcanic action, why were not the *Gadidæ*, skates, and other cold-water species exterminated as well as the Tile-fish and other animals which Professor Verrill has said are considered tropical and subtropical forms?

It seems scarcely worth while to dwell any longer on this subject since a bare allusion to other possible reasons for the death of the Tile-fish will suffice.

That fish are often killed by disease, by troublesome parasites, by larger fish, and, perhaps, in the case of inland waters, by poisonous substances mingling with the streams, there can be no doubt.*

* The following accounts of the death of fishes, evidently from widely different causes, may be of interest in this connection: "The Harbor Grace Herald, (says the Gloucester Telegraph of August 10, 1853,) gives the following particulars of a mortality among the capelin, a small fish, which forms a large portion of the food of the Newfoundlanders:

"'It is a singular fact that within these few days past multitudes of dead capelin have been thrown ashore in the land-washes or seen floating on the water in various parts of this bay. What is still more extraordinary, and renders it probable that the creatures have been attacked with some internal disease, is the fact that thousands of them have been seen dying on the surface of the sea, their gill-covers distended and their under parts, between the pectoral and anal fins, discolored with eruptive spots.

"'In this state hundreds of barrels have been cast ashore in different parts of the coast.'" * * *

In the same paper of September 10, 1845, is the following:

"We learn that during the latter part of last week immense fields of small fish, floating dead upon the water, were to be seen in the harbor. They were of the kind called alewives, and in one place not less than an acre of them turned up their white sides to the sun. What was the cause of this mortality is unknown." (Baltimore Sun.)

But in the case of the *Lopholatilus,* there seems to be no reason whatever to suppose that any of these reasons could be assigned as a probable cause of death. The specimens obtained were said to be sound, wholesome, and handsome. When cooked, they were nutritious and remarkably palatable. They were not killed by other fish, for they were not mutilated. Neither could they have been destroyed by disease or by the ravages of parasites, for their appearance indicated the most robust health and freedom from injurious insects. Whatever the cause, it is evident that the fish were overtaken by some power which suddenly suspended their vital action, and transformed them almost instantly from active, vigorous animals into a mass of inert or dying forms floating helplessly at the surface of the sea.

E.—APPENDIX.

15.—REPORT UPON A CRUISE MADE TO THE TILE-FISH GROUND IN THE SMACK JOSIE REEVES, SEPTEMBER, 1882.

The area of sea bottom lying inside of the Gulf Stream, near the parallel of 40° north latitude, and between the meridians of 70° and 71° 20′ west longitude, in depths varying from about 90 to 125 fathoms, is where the Tile-fish (*Lopholatilus chamælonticeps*) has been found abundant during the past three summers, and this locality is known as the "Tile-fish ground," and here, as well as much farther south and west, dead fish of this species were seen floating in vast numbers at the surface of the ocean last March and April. The object of this trip was to ascertain by practical methods, and as complete a research as circumstances would allow, to what extent the Tile-fish had been depleted by the mortality of last spring, or if they had been practically annihilated in the region where they have heretofore been known to occur. The investigation of this subject was therefore a matter of unusual interest, whether we look at it from a scientific stand-point or whether we take into consideration how much benefit might result to those engaged in the fisheries, should the Tile-fish be found in anything like its former abundance, and its commercial value be established. This species has been pronounced a most excellent food-fish by competent judges, and there is reason to expect that its market value might have been fully equal to that of many of our choice fishes had sufficient numbers been taken to place it before the public as an article of food.

In obedience to the tenor of your orders that I should proceed to the Tile-fishing ground and ascertain the presence or absence of the *Lopholatilus chamælonticeps*, I have the honor to submit the following report:

I left Gloucester September 15, 1882, to join the schooner Josie Reeves, which was then at Greenport, Long Island, waiting my arrival. I had previously forwarded the fishing apparatus, trawl lines, &c., that I had

prepared for the trip. My intention was to have started on the 14th, but the prevalence of an easterly storm, accompanied by high winds, together with some difficulty I had in obtaining the lobster-pots, delayed my departure.

Going by the Fall River line, I reached New York on the morning of the 16th. On arriving at the city I went at once to the office of Mr. E. G. Blackford, Fulton Fish Market, in order that I might learn of him whether all the tanks, jars, and other materials for preserving specimens (which articles were sent to his care) had been forwarded to the smack. All of these details had been carefully attended to by Mr. Blackford; and I learned from him that, besides the provision made for the preservation of material in alcohol, there was sufficient ice on board of the schooner for the refrigeration of our bait and any number of fish we were likely to capture.

Having ascertained these facts, I went by the afternoon train (the first one leaving New York) to Greenport, where I arrived at 6.40 o'clock in the evening. Mr. Barnet Phillips, who accompanied us on the cruise and who had joined the smack in New York, and Captain Redmond, skipper of the Josie Reeves, met me at the depot. I went with them on board the schooner then lying at the wharf where the menhaden steamers rendezvous when in port.

I learned from Captain Redmond that all the material for the trip, with the exception of the lobster-pots which I had sent from Gloucester, had been received and was snugly stowed away on board of the smack. However, owing to the prevalence of rough weather during the preceding four or five days, no menhaden had been caught, and therefore it had been impossible to procure a supply of bait for the cruise. It is true, perhaps, that bait might have been obtained from the weirs in the vicinity of Sandy Hook when the smack left New York, but to have taken it then, with a storm of uncertain length impending, would have been very unwise, since the probabilities were that it might be unfit for use before a chance offered to go to sea. Under the circumstances, there was nothing to do but to wait until Monday.

Captain Redmond thought our best chance of obtaining bait would be from the weirs in the vicinity of Greenport. Therefore, on the next day, the 17th, we procured a team and drove to all the fish traps which could be reached. We found, however, that the prospect of getting "bunkers" from the pounds was not good, for most of them had been either torn up or so badly injured by the storm that there was little chance of securing enough menhaden to answer our purpose. The only thing that could be done under the circumstances was to wait until the fishermen went out in the sound, when, if the fish "played" well, we might get bait from the seining gangs.

At daylight on Monday, the 18th, there was a smart southerly breeze with indications of rain. The steamers had started between midnight and dawn, and the sailing gangs, which were out early, looking for fish,

finding the wind too strong down Gardner's Bay, began working up by Greenport under reefed sails, towards the more sheltered waters of the Great Peconic Bay. Altogether the prospect of getting a supply of bait was not promising for that day. Towards noon, however, the appearance of the weather changed very much, and the afternoon was fine, with a moderate southwesterly wind.

We were reluctantly compelled to wait for our lobster-pots until the arrival of the steamer from New London at 11.30 o'clock a. m. We then got under way, but seeing no indications of the presence of menhaden as we ran down Gardner's Bay, we decided to work up the sound, feeling confident that we should have a better chance there to meet the fleet of steamers that had gone in that direction; there was also a probability of getting menhaden from the pounds on the Connecticut shore. When off Cornfield light-ship we saw several "bunches" of "bunkers," but as there were no seiners in sight we kept on our way. The pounds along the shore, which we approached quite closely, had met with the same fate as those at Greenport, being rendered unfit for fishing by the late gale. At about 8 o'clock in the evening, having reached the vicinity of Guilford, where there is an oil and guano factory, we came to anchor near Falkner's Island, expecting to have an opportunity the next morning to secure bait from some of the fishing gangs which were thought to be at that place. Another reason for our anchoring was that the tide had turned against us, and, the wind being light, we could not hold our own under sail.

The morning of the 19th was calm and fine, and after daylight we saw numerous "bunches" of menhaden playing at the surface near where we lay anchored. At that time there were the two sloops of a "sailing gang" lying at anchor close inshore, but they did not get under way until some time after sunrise, when they began working off shore, taking what advantage they could of the occasional "cat's-paws," which, later, became more steady, though the wind continued very light. The boats gained little, however, and feeling anxious to secure their assistance in procuring bait, and fearing that they might go in some other direction if the wind breezed up, I, with two of the smack's crew, started to board them in one of our dories. We had about 2 miles to row, but the distance was soon passed over, and we boarded the larger of the sloops—the one having the fishing gang on board—the other being the carryway boat.

Having first told the captain of the gang that there seemed to be an abundance of fish near our vessel, I asked him if he would sell us bait enough for our trip, telling him for what purpose the cruise was undertaken. Though entirely willing to furnish us with bait, so far as he was personally concerned, the captain explained that he was not permitted to sell any menhaden for such a purpose, but said that if I would go ashore and get the consent of Captain Fowler, one of the proprietors of the factory, and who, we were told, is president of the Oil and Guano

Association, he would most gladly supply us with bait. Accordingly we went to the factory, but learned that Mr. Fowler had just driven off to "town" (Guilford) and would not return for the day. The foreman in charge of the factory, to whom we explained why we landed, thought there would be no objection to our procuring bait, but was not disposed to assume any responsibility.

As nothing further could be done we returned to the Josie Reeves, and, the wind having breezed up slightly in the interim, we got under way and stood in the direction of the sloop we had boarded, and which at this time had worked off on the ground a little over a mile distant from us. Soon after filling away we saw the boats out, setting the seine, and the breeze being too light to gain much in the vessel, I started off again with two of our men to buy what bait we needed if the seiners succeeded in making a good catch. A fair-sized "bunch of fish" had been surrounded, and our men helped to gather in the twine during the "drying in" process. The "boss" of the gang thought he had from fifteen to twenty thousand fish in the net, and there was every prospect of securing the entire lot, when, just as the men were ready to "bail out" the fish, a large hole was torn in the seine (due to the rottenness of the twine or the bite of a shark or dog-fish), and the bunkers went streaming out through the "tear," leaving only a few—perhaps one-tenth of the whole—which were hastily gathered in one corner of the bunt, and scooped on board of the carryway boat. The skipper had consented to supply us with bait, on condition that I should write a letter to the owners of the factory explaining the purpose for which it was obtained.* The failure to get this school was as much a disappointment to us as to the fishermen themselves, possibly even more so, for we were very anxious to improve the favorable wind to run down the Sound, and also felt some uncertainty about getting bait before night.

However, another set was made by the crew of the sloop, but the result added but little to the first catch, the whole amounting to only 2,200 fish, which we took on board and packed in ice. By this time it was getting late in the afternoon, the fish had stopped schooling, the sailing gang manifested a disposition to go in harbor, and a loaded steamer, bound to Greenport, which we unsuccessfully tried to head off, paying no attention to our signals, there seemed little probability of getting the rest of our bait before night. But a sharp lookout was kept for homeward-bound bunker steamers, and at 5 o'clock p. m. we were for-

* This letter was written and addressed to Messrs. Fowler & Colburn, Guilford, Conn., as follows: "Being in want of menhaden for bait wherewith to make a fishing trip to the grounds lying inside of the Gulf Stream, in the interest of the United States Fish Commission, we have applied to the captain of the sloop Fanny, who has kindly consented to furnish us with a supply on condition that I shall write this letter of explanation to you. I trust you will commend his action in this matter, since we have been prevented from obtaining bait for several days on account of the recent rough weather, and because of the importance of this investigation, which might be much delayed, if not rendered abortive, should we be unable to procure bait now."

tunate enough to meet with the William A. Wells, on her way to Greenport with a cargo of menhaden. The captain, who knew the Josie Reeves, and understood why she was there, very kindly stopped his boat and sold us 2,000 fish at $5 per thousand. He also took our mail.

We then filled away and ran down the Sound with a brisk southerly breeze, carrying all of our light sails. At 8.40 p. m. passed Little Gull Rock and at 10.30 p. m. Montauk Point light bore SW. by W. about 5 miles distant. At that time we hauled to, steering a S.SE. course, and as there was some head sea and the wind had freshened, we took in the balloon jib and staysail.

The morning of Wednesday, the 20th, was fine, with a brisk breeze from S.SW. About 8 o'clock, however, it was foggy, but soon after it cleared off, and the weather continued fine throughout the day, though the wind was somewhat variable, backing southerly for two or three hours at a time, and then hauling back again.

At sunrise all hands were called, and we began making preparations for setting the gear, and during the forenoon we baited a cod and haddock trawl, each having 1,000 hooks. We thought it possible in the morning that we might get to the Tile-fish ground early enough to make a set with the trawls, but the wind being moderate and variable in the afternoon we did not reach deep water until 3.55 p. m., when we sounded in 118 fathoms, our position at that time by dead reckoning being 40° 4′ north latitude, and 70° 30′ west longitude, about a mile from the position where the Fish Hawk found Tile-fish abundant August 23, 1881. The day was too far advanced, however, for us to set the trawls, so we hove to for the night.

A short time before reaching deep water (shortly after 3 o'clock) we saw several fin-back whales. A little after 4 o'clock we noticed three or four schools of small fish, which were apparently about the size of large mackerel. At times they showed a ripple like mackerel or herring, and very frequently many of them would spring from the water together, making long dolphin-like jumps. We ran for the schools in hopes to approach them near enough to find out what species the fish were, but they sank before we got close enough to them, and a troll-hook which we put out failed to catch any.*

The evening was fine, with brisk S.SW. wind. We lay to under mainsail and jib with head to the eastward during the first half of the night, after which we jogged the opposite way.

Thursday morning, the 21st, was overcast, with a moderate S.SW. breeze, but after sunrise the weather cleared off beautifully with a slight increase of wind.

At daylight we set the trawls under sail, beginning in 160 fathoms and running the gear northwardly towards shoaler water. After the trawls were out we sounded at the lee ends, getting a depth of 135 fathoms, the bottom being mud, sand, and broken shells. Our position

* It is probable that the fish we saw were mullet.

was latitude 40° 3′ north, and longitude 70° 28′ west. Captain Redmond went in one of the dories (as he did during the whole time we were on the ground), leaving me to manage the smack with the assistance of the cook, while Mr. Phillips busied himself in taking notes on this method of fishing, which he now saw for the first time.

Being entirely unacquainted with the strength of the current in this locality, we put four buoys on each trawl—two on an end—to make sure that the gear should not be lost by the submergence of the kegs. We found, however, after the trawls were set, that there was only a moderate tide setting to leeward in a northeasterly direction, and apparently only at the surface.

We began hauling the trawls at 8 o'clock a. m., and picked up the last dory at 10.15. Only three fish were caught. These were a hake (*Phycis*), a grenadier (*Macrurus*), and a whiting, or silver hake (*Merlucius*).*

After getting the boats on board we ran to the westward, the men in the mean time being busy in baiting the trawls, which we set again at 2.30 o'clock p. m. in from 130 to 150 fathoms,† our position being latitude 40° 2′ north, longitude 70° 41′ west.

The gear was hauled late in the afternoon. We caught about twenty hake (*Phycis*), four or five silver hake (*Merlucius*), several skates (*Raia*), of which we saved two specimens, and three handsome fish of a species which I had not previously seen,‡ besides a limited number of invertebrates. All of the largest fish were iced, as well as one of the rare ones, which we were in hopes might prove of special interest, and which we preferred to keep in ice, so that it would retain its color. The other two were put in alcohol, as also were the invertebrates.§

Owing to the fact that we were uncertain about the strength of the current in the morning, and had so little time for the afternoon set, we did not put out any of the lobster pots. It is, perhaps, proper to remark here that fishing, as we were, under sail, and exerting ourselves to the utmost to make as many trials as possible in a given space of time, little could be done with lobster pots in deep water, though it is entirely reasonable to suppose that they might be set from a vessel at anchor

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*These, with the exception of the first, were put in jars, with other material (invertebrates), and labeled "Lot No. 1."

†In all cases the trawls were set at right angles to the trend of the ground, which here extends nearly east and west, sloping quite rapidly to the southward, so that a trawl, being nearly a mile long, might be in 150 fathoms where its southern end lay, while at the northern extremity there would not be more than 120 or 130 fathoms. It seemed desirable to place the gear so that, as far as circumstances would permit, various depths might be reached, since it often happens that some species of fish which may occur in great abundance at a depth of, say, 130 fathoms or more, can be rarely taken in shoaler water, while other kinds would be found most plentiful where it was not so deep.

‡This species has since been identified as the *Sebastoplus dactylopterus*. Immature specimens had previously been found on our coast, but no adults had been taken. It also occurs in the Mediterranean and at Madeira.

§This collection was labeled "Lot No. 2."

on a hard bottom with excellent results. When making "flying sets," to "try the ground," it is desirable that the gear shall sink as soon as possible, in order that it may soon be hauled in again. Lobster pots, of the ordinary pattern are somewhat unwieldy and sink slowly, and the necessity for speedy action when fishing under sail makes it desirable to pull them in again before they have been sufficiently long on the bottom to secure the best results.*

After hauling our trawls we ran to the westward about ten miles and hove to for the night, with the "jib to the mast."†

During the day the wind had backed easterly, and at sunset was southeast, blowing a moderate breeze. The weather at that time was fine, but the sun "setting in a bank" gave us reason to suppose that it might be less favorable on the next day.

Friday morning, the 22d, there was a fresh southeast breeze, with indications of stronger wind, and possibly rain before night. Orders had been given the previous night to exercise considerable care to keep our position, and so well was this attended to that at daylight we sounded in 140 fathoms. At this time the men were called out to bait the gear. One man was sick, therefore we set only one string of trawl, which we put out at 8.30 a. m. in 125 fathoms, latitude 40° 1′ north, longitude 71° 2′ west, by dead reckoning.

We hauled the gear at noon, three men going in the dory. At this time there was a strong and increasing wind with a choppy sea going. As there was little probability of its moderating enough to set again in the afternoon, we took the dory on deck, took care of the catch, and stowed the trawls below.

On this occasion ("Lot No. 3") we caught twenty-five or thirty hake, several silver hake, and eleven specimens of the remarkable red fish which we had first seen the day before. One of the latter was so badly eaten by slime eels that it was thrown away. Several of the finest specimens were put on ice, while the rest, with the exception of two, which we ate, were put in alcohol. Mr. Phillips, believing the species might be new to science, and deeming it an important matter to determine its qualities as a food-fish, suggested that we should eat one, as

* On the ground where we were fishing it would probably have made little difference, for the slime eels (*Myxine*) were so plenty that they invariably consumed the bait when the pots were set at a later date, and it is very likely that their presence in such great numbers would have prevented the entrance of other and more desirable species, which might otherwise have been captured.

† This is a favorite method of heaving a vessel to on the fishing-ground among the market fishermen from New York to Portland, Me. The jib is trimmed flat, so that its clew is nearly amidships, or it is held in about the same position by a "tail rope" from the weather bow. The helm is then secured in such a manner that the vessel, by lying first on one tack and then on the other for greater or less time, will hold her position much closer than would be expected. However, to accomplish this successfully requires the peculiar knowledge of these vessels, and the skill to manage them possessed by the fishermen, and which only long experience can give.

no one could say when another opportunity might offer to obtain fresh specimens. Fully concurring in his opinion, I had two of them cooked, and we found them most delicious, with firm crispy flesh, and a delicate flavor that would be hard to equal.

In the lobster pot only slime eels were taken. These were placed in alcohol.

It is perhaps worthy of remark that in all the fish which were eviscerated not the least trace of food was found, and I am at a loss to know why species so voracious as the hake, whiting, and others, which we took, should be found in a locality where there is evidently little food to be obtained.

The scarcity of sea-birds might be cited as an indication of a limited amount of small fishes, or other forms near the surface. However, an occasional hag (*Puffinus*) was seen, and several varieties of jægers, which appeared more common in this region than other forms.

At 1 o'clock p. m. we kept off and ran to the westward 15 miles by the log.* At 3.45 p. m. we sounded, and having got a depth of only 50 fathoms, let the vessel jog under mainsail and jib, on the port tack, slowly head-reaching to the southward. At sunset there was less wind and occasional light showers. By the exercise of much care, and sounding frequently during the night, the vessel was kept on the edge of the ground so closely that at 5 o'clock on Saturday morning, the 23d, we were in 150 fathoms At this time there was a moderate S. SE. breeze, but considerable ground swell, which increased somewhat later in the day. The sky was overcast with broken clouds, though there was no appearance of thick weather.

All the men were called to bait the trawls at dawn. Being anxious to make two sets during the day, and knowing that we could not if we set two trawls at once, we baited only one string—a thousand hooks—which we set between 8 and 9 o'clock a m. in from 100 to 125 fathoms; latitude 39° 54′ north, longitude 71° 22′ west. After the trawl was set we left one of the dories fast to the lee end, since the ground swell rendered it difficult to see a buoy flag any distance. We began hauling the gear at 11 o'clock, a dory going to each end of the trawl, and shortly after noon the men had finished the work. But little was taken on this haul—"Lot No. 4"—it consisting of a few hake, three dogfish (*Squalus*), and a few invertebrates on the trawl, and nearly a bucket full of slime eels (*Myxine*), and a single crab in the lobster pot, which we had fastened near one of the anchors.

As soon as we had finished hauling we kept off southwest by west, and ran a little over 5 miles on that course, when, having got a depth of 110 fathoms, we set one of the trawls, which we had baited during

* I take this occasion to mention that the captain of the yacht "Madeline," which lay in winter quarters at Greenport, kindly lent us the yacht's patent log, which we found very serviceable. The log was returned through Captain Redmond, with a letter of thanks and acknowledgment of the favor conferred.

the forenoon while the first one was out. The position of this set was, latitude 39° 50′ north, longitude 71° 25′ west. The trawl was hauled at 4.30 p. m. by three men, who went in one of the dories. This was necessary, as one of the crew was ill, and also because at this time the increasing wind and sea made the hauling of the trawl a matter of some difficulty for two men to accomplish. The catch, which contained nothing of interest, consisted of about thirty hake, and a single specimen each of dogfish (*Squalus*) and monkfish (*Lophius*), all of which we iced.

The investigation having now continued uninterruptedly for three days, and 50 miles along the edge of the ground having been tried over, with not the slightest indication of the presence of the Tile-fish, to search for which was the object of the trip, and the appearance of the weather being such that strong winds and a rough sea might be expected for the next two or three days at least,* I concluded that nothing could be gained by staying longer on the ground. One reason for this decision was that our bait, though we had had it on board only five days, had already begun to show signs of deterioration, and it was obvious that, should we have rough weather for three or four days, which was very likely to occur at this season, the menhaden would be entirely unfit for use, and the cruise would have to be given up then even if there should be a return of fine weather. The chances, therefore, were that a longer stay would only add to the expense of the trip without the attainment of any additional results. Other important business, which required my attention, also made it extremely desirable that no time should be wasted. Besides all this the time for which we had chartered the smack had nearly expired, and Captain Redmond was very desirous of resuming his business of lobster carrying, since he feared his trade might be injured by a longer absence.

I had hoped to continue the investigation for eight or ten days at least, and to have prosecuted the research some distance farther south, though the probabilities are that little more could have been accomplished so far as catching Tile-fish is concerned. Nevertheless, it would have been more satisfactory if the weather had permitted us to stay long enough to settle all doubts as to the presence or absence of the *Lopholatilus* within certain limits. However, this not being practicable for the reasons given above, it was decided to run for the land. Accordingly we kept off at 5 o'clock p. m. The wind at that time blew fresh, and continued strong and steady through the night. At 2 o'clock Sunday morning, September 24, we made Block Island light. After getting nearly abreast of the island we hauled up more, and, passing through Buzzard's Bay and Quick's Hole, reached Wood's Holl about 9 o'clock

* The spell of rough easterly weather that began at this time continued uninterruptedly for eight days, and there is little probability that the least chance would have offered to set trawls, especially when we consider that a large fleet of mackerel schooners was kept in harbor during all this time, and many vessels engaged in the cod and halibut fisheries were prevented from sailing by the same cause.

a. m., just in time to escape a dense fog, which, coming in from sea, completely obscured all but the nearest objects. The apparatus which we had on board of the Josie Reeves, and as much of the collection as was considered valuable, was landed during the day, and Captain Redmond was left free to proceed to New York as soon as the weather permitted him to sail, which he did on the following morning.

Before closing this report it is proper that mention should be made of the efficient aid rendered by the captain and crew of the Josie Reeves in the prosecution of this investigation. The cheerfulness with which they engaged in the most arduous labor, and the zeal they exhibited in collecting and in doing all that pertained to the work we had to perform, was certainly commendable, and rendered my duty much pleasanter than it otherwise would have been.

I would also improve this opportunity to acknowledge the obligations I am under to Mr. Phillips for suggestions which were valuable and well timed.*

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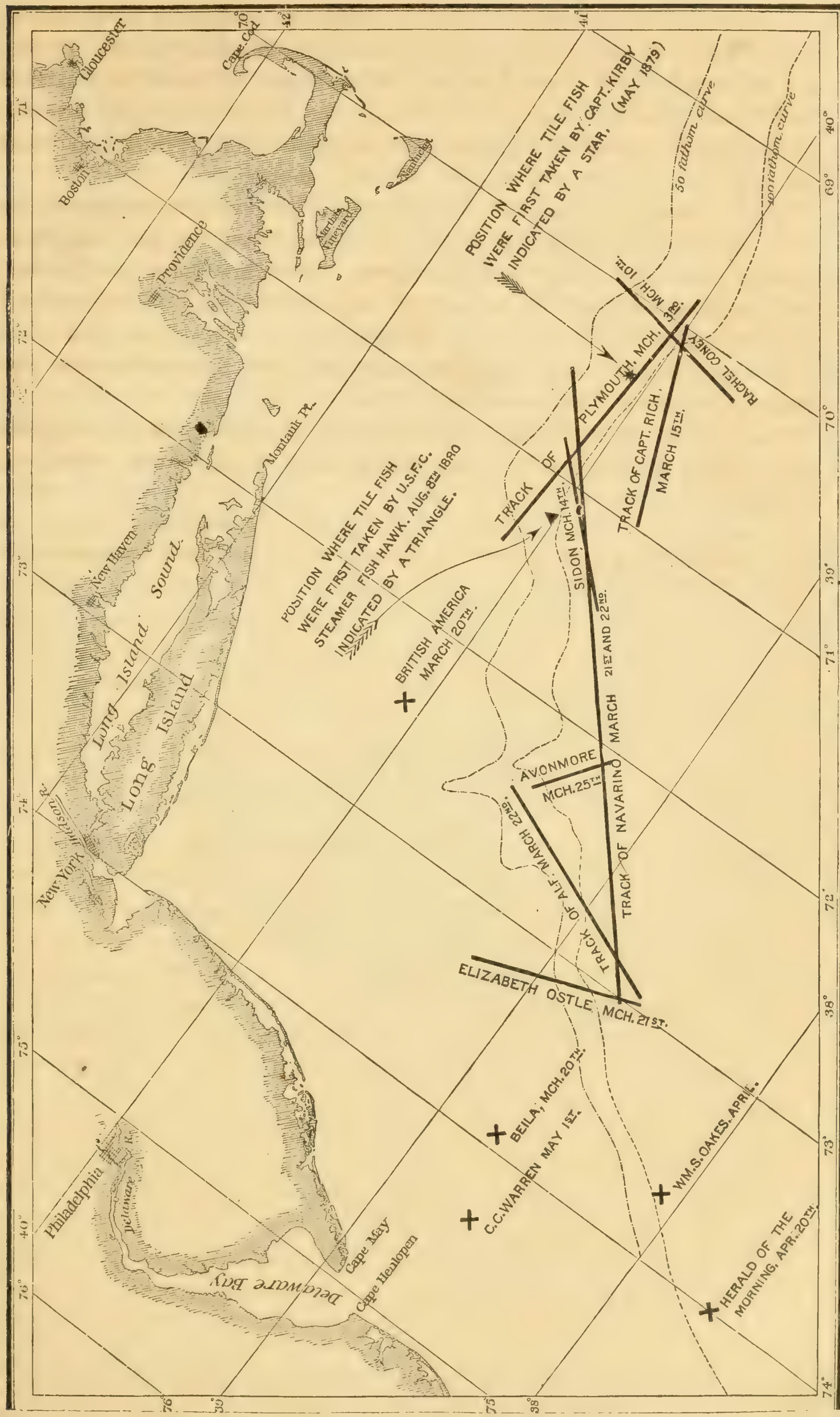
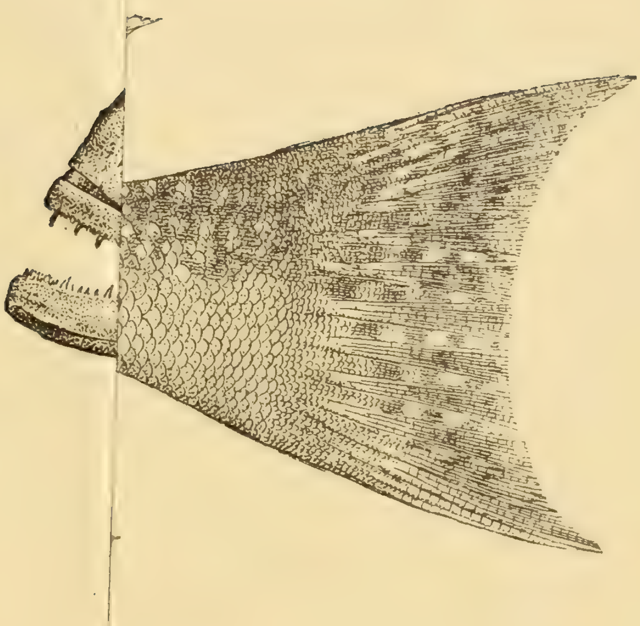
* The Appendix is reprinted from Bulletin of the U. S. Fish Commission, vol. II, 1882, pp. 301–310.—Editor.


Gloucester
Boston
Cape Cod
Nantucket
Marthas Vineyard
Providence
Montauk Pt.
New Haven
Long Island Sound.
Long Island
New York
Hudson R.
Philadelphia
Delaware
Delaware Bay
Cape May
Cape Henlopen
POSITION WHERE TILE FISH WERE FIRST TAKEN BY CAPT. KIRBY INDICATED BY A STAR. (MAY 1879)
POSITION WHERE TILE FISH WERE FIRST TAKEN BY U.S.F.C. STEAMER FISH HAWK. AUG. 8TH 1880 INDICATED BY A TRIANGLE.
50 fathom curve
100 fathom curve
MCH. 10TH.
TRACK OF PLYMOUTH, MCH. 3RD.
RACHEL CONEY
TRACK OF CAPT. RICH. MARCH 15TH.
SIDON, MCH. 14TH.
MARCH 21ST AND 22ND.
TRACK OF NAVARINO
BRITISH AMERICA MARCH 20TH.
AVONMORE MCH. 25TH.
TRACK OF ALF. MARCH 22ND.
ELIZABETH OSTLE, MCH. 21ST.
BEILA, MCH. 20TH.
C.C. WARREN MAY 1ST.
WM. S. OAKES. APRIL.
HERALD OF THE MORNING, APR. 20TH.

Repo

PLATE II.



The Tile Fish (*Lophalatilus chamaleonticeps*).

INDEX.

NOTE.—The references are to page-figures in brackets.

XII.—MEMORANDA OF METHODS EMPLOYED BY FISHERMEN FOR "BARKING" AND IN OTHER WAYS PRESERVING NETS AND SAILS.

By F. H. Storer.

Seafarers are familiar with the fact that upon several foggy coasts, notably those of Scotland and of the islands north of it, as well as the coasts of Cornwall, Nova Scotia, New Brunswick, and Newfoundland, the fishermen habitually tan or "bark," as the saying is, the sails of their boats, and their nets also, in order to protect them from rot and mildew. That is to say, they are accustomed to stain the sails a dingy reddish brown color by means of materials containing tannin, such as are employed in the ordinary process of tanning leather.

The process is manifestly an old one, and references to it may be found very early in the works relating to technology. But the methods employed seem to be to the last degree empirical in most localities, and the subject appears never to have received proper attention either from professional dyers or from scientific men. It is regrettable that the systematic works on dyeing, occupied as they have been with the practical and æsthetic side of the art, have hitherto paid little heed to the rough domestic processes which are of special historic interest. It is high time that these rough and often imperfect processes should be recorded and studied, both from the scientific and archæological points of view.

In seeking for what I might find printed concerning the tanning of sails I have come across several items which seem to be worthy of publication, as bearing upon the early history of the art of dyeing. I am the more especially impelled to print these notes, since no chemist, in so far as I am aware, has ever seriously considered the methods of coloring that are employed by the fishermen. Indeed, these processes have seldom been alluded to by chemists of late years. The common notion of deep-water sailors that the canvas to be stained is simply soaked in tan-pits, as hides are in the process of making leather, seems at first sight hardly probable in view of the depth of the color imparted to the sails in some localities, and of the well-known difficulty of dyeing strong, fast colors upon either linen or cotton except with the aid of mordants. Nevertheless, it appears that the sailors are very nearly right in their supposition, and that simple dipping of the sails in this sense, or, rather, boiling them in tan liquor, is a very general practice. Most of the references which I have found in books relate to it. Thus,

in William Lewis's "Philosophical Commerce of the Arts," London, 1763, **2**, 429, it is stated that fishing nets receive a pretty durable stain from soaking in astringents. Chomel's "Dictionnaire œconomique," Paris, 1767, **2**, 88, directs that nets may be colored by boiling them in tan liquor, or in a decoction of the bark of walnut roots; or the net may be rubbed with celandine or young wheat when a yellow or green color is wanted. So, too, in Chambers's Cyclopædia, Dublin, 1782, vol. 3, article Net (in Fowling). Similar directions will be found in several of the earlier dictionaries of rural affairs, and in many old books relating to country sports, such as hunting and fishing. In the "Dictionnaire de Marine," by Willaumez, Paris, 1825, p. 547, it is said that French fishermen soak their sails in a decoction of oak bark and red ochre to preserve them. James Anderson, in his "Account of the Hebrides and West Coast of Scotland," Edinburgh, 1785, pp. 336, 344, says that nets and sails are there tanned by simply soaking them in hot tan liquor from oak bark. The Encyclopædia Britannica, article Net, p. 105 of the edition of 1842, says the most usual color given to nets is the russet, which is obtained by plunging the net into a tanner's pit and letting it lie there till it be sufficiently tinged; this is of a double service to the net, since it preserves the thread as well as alters the color. Good, in Dingler's Polytechnisches Journal, 1820, **2**, 162, explains how he tans nets and sails by boiling them in tan liquor; and the same account is given in C. Mackenzie's "One Thousand Experiments in Chemistry," London, 1821, p. 508. Millett, Polytechnisches Centrallblatt, 1847, p. 1285, cited in Elsner's Mittheilungen, **1**, 124, says fishermen merely soak their nets in hot tan liquor. He himself put some linen thus treated in a damp cellar and kept it for years. Wimmer, Dingler's Polytechnisches Journal, **121**, 372, repeated Millett's experiment with success. H. de la Blanchère, in his "Nouveau Dictionnaire général des Pèches," Paris, 1868, p. 763, says nets are tanned to hinder them from rotting. A quantity of ground oak bark is boiled for a couple of hours in rain water, and the still boiling liquor is poured upon the dry clean net, which has been placed in a tub. The net is well kneaded in the liquor and turned several times during the day. It is then left to soak during thirty-six or forty hours; finally it is withdrawn from the liquor and dried. The operation is repeated once a year. It has become more and more common to use catechu for tanning sea nets, and to-day most of them are preserved with this material. Being much richer in tannin than oak bark, it tans the nets more strongly and preserves them better. The operation is performed in the same way by means of hot water saturated with catechu, often admixed with oak bark to lower the price a little. The tanning of lines, also, especially for sea fishing, is an important operation, both because they last longer and because they are less visible. A dead-leaf color is obtained by chopping walnut bark or oak bark fine and boiling the fragments one hour in water. The lines are placed in the vessel among the bark and left to soak twenty-four

hours. They are then taken out, wrung, and dried. Catechu may be substituted for the bark; it acts quicker and gives a more solid color. A dirty orange color is obtained by collecting a quantity of the plant *Chelidonium Majus* in the fields and simply rubbing the lines with the green plant, so that they may be impregnated with the juice. The lines are then dried and the process is complete. A green color is obtained from young wheat plants chopped and pounded and boiled. The lines are soaked in the liquor twenty-four hours. In addition to the foregoing, Walton is credited by de la Blanchère with a method of dyeing lines with walnut leaves, beer, and alum.

I have myself made numerous inquiries of people likely to know something about the subject, and I am greatly obliged to many persons for the information they have given me and the pains they have taken to procure information. The well-known ichthyologist, Capt. Nath. E. Atwood, of Provincetown, in particular, put me in personal communication with fishermen from Nova Scotia, who in their own country had been accustomed from early youth to the barking of nets and sails. The accounts given by these men were explicit and concordant, to the effect that the bark of fir and spruce trees was collected in the woods and boiled thoroughly in water. The nets having been placed in tubs, the tan liquor was poured over them, the bark being thrown on top, and the nets were left to soak in the liquor during twenty-four hours. This operation was usually performed once a week, the common plan being to put the nets in soak Saturday night and leave them soaking over Sunday. These Nova Scotians were emphatic that nothing whatsoever was mixed with the tan liquor, or put upon the sails in conjunction with the tan. On the contrary, it was customary, they said, to use new sails in the boats for a short time before coloring them, in order that any grease or starch in or upon the sails might be washed out by rains and worked out by use. So too, the small amount of oily matter which is habitually put upon flax to make the fibers work more easily in the process of manufacturing it into cloth is always washed out with soap and water before the twine or canvas comes to be subjected to the tanning process. They state that when the nets are in use the color soon washes out of them, and that the process has to be frequently repeated on this account. In their eyes, the purpose of the tan liquor seemed to be rather to "kill the slime" which is left upon the nets when fish are captured than to permanently protect the twine from putrefactive influences. They said the same process was used for sails as for nets, only the sails were not soaked so often; they were dried after soaking. Immediately after dipping the sails were very dark, but the color gradually washed out of them. Nothing was ever added to fix the color, or, as one of my informants put it, "to set the tan." This same man stated that in the domestic economy of his locality the dyeing of linen articles was habitually practiced, and that his people were accustomed to use copperas and alum to set a variety of colors on household goods.

It may here be said that the use of copperas for dyeing fast blacks and browns of various shades as well as drabs and slate color, on cotton and linen by means of decoctions of different barks, husks, and leaves (such as those of the walnut, oak, maple, alder, beech, sumach, willow, pine, etc.), is common in American households, from Nova Scotia to Florida, as I am assured by several friends, and as has frequently been published (compare, for example, Dr. F. R. Porcher's "Resources of the Southern Fields and Forests," Charleston, 1869, pp. 215–217). The traditional "butternut" garments accredited to the Southern soldiers during the war are said to have been dyed in this way. Porcher (p. 215) says: "Those who cannot obtain copperas use the water from one of the mineral springs, which is strongly impregnated with iron." On pages 217 and 241 he urges that "vinegar and rusty iron will often fix colors without the aid of copperas"; and again, on page 302, he says, that "blacksmith's dust may be used in place of copperas." Others have suggested that in default of copperas, the mere act of boiling the cotton and the dye-stuff in an iron pot, preferably a clean one (*i. e.*, new and free from grease), may help to fix the color; and it is not impossible that the influence of iron dissolved from the pot by acids in the dye-stuff may have been felt to a certain extent in this sense, in some cases to be alluded to directly, where fast colors are said to have been obtained by means of barks without using any mordant; besides copperas, alum and blue vitriol are freely used in this country for various purposes in domestic dyeing.

Of late years catechu seems to have superseded bark in many localities. It is now freely used by fishermen both in Europe and America. I have myself known of boatmen occasionally soaking their mooring painters in a solution of it, to preserve them from decay, and I have seen simple catechu applied to the sails of boats also, to preserve them from mildew. It was thought to serve a good purpose, though, unless pains are taken to turn the sail frequently while it is drying, *i. e.*, while the catechu is undergoing oxidation, one side of the sail will be darker than the other.

J. G. Nall[1] says herring nets are usually made of a strong two-thread hempen twine, which undergoes a process of tanning in cutch, *i. e.*, catechu, a solution of which gives the twine a brown hue. In the autumn, the surface of the Yarmouth Denes, covered over with nets spread out to dry, has the appearance of a tan-pit. Oak and ash bark were formerly employed. Care has to be taken not to over-tan the nets, the meshes of which would become contracted and too much hardened. The nets are tanned in the beginning to preserve them from rotting, and the process is repeated at the close of the fishery in order to cleanse them thoroughly. A mackerel net will outlast several herring nets. They are neither exposed to the havoc created by the dogfish, nor to the grease

[1] "Great Yarmouth," &c., London, 1866, pp. 290, 291, 293.

with which the nets are saturated from the herrings, and which rots them rapidly unless they are continually cleaned.

On inquiry at one of the largest manufacturers of nets in Boston, I found, as was naturally to be expected, that the net makers use catechu in a very different way from the fishermen; that is to say, they fix it methodically with bichromate of potash as would be done at a dye-house in the case of any other cotton or linen goods. By the manufacturers, the nets are steeped in a hot aqueous solution of catechu, and then treated to a bath of the bichromate, whereby the color is oxidized, darkened, and "fastened" to the twine in the manner familiar to dyers. It is a process that has to be managed with care lest the netting should be weakened. Extract of hemlock bark, they told me, might be used instead of catechu, but it would cost more. It is only the lighter nets, such as herring nets, that are stained with catechu in Boston. The heavier nets are tarred; and, according to my informant, his firm tar many more nets than they tan. It did not appear that tar and catechu are used together by the Boston dealers, as they are in some places.

It is a fact well known to dyers that linen and cotton can be stained, after a fashion, by the use of tanning materials even when no mordant is present. Bancroft[1] says: "There is a species of coloring matter diffused in greater or lesser proportions through the barks and other parts of almost all trees and shrubs, and which, without any basis or mordant, permanently dyes or stains wool, silk, cotton, and linen, of that particular kind of color which the French call *fauve* (fawn color), and sometimes *couleur de racine ou de noisette* (root or hazel nut color). * * * It is found most abundantly in the peelings, rinds, or husks of walnuts, in the roots of walnut trees, in alder bark, etc.; and it seems to acquire both body and permanency by attracting and combining with pure air." Domestic processes of dyeing cotton, in this sense, by simply soaking in tan liquor and ageing, are sometimes mentioned in the agricultural newspapers.[2] But in spite of this familiar knowledge, it would still be remarkable if so dark and so durable a color as is actually seen on the sails in some regions had been imparted to them by merely soaking or boiling the canvas in tan liquor. As bearing upon this point, I may cite the following sufficiently explicit statement from a very old authority.[3] For the sake of enforcing the contrast between cotton and wool the author premises that "vegetable filaments, and thread and cloth prepared from them, differ remarkably from wool, hair, silk, and other animal productions, * * * in their disposition to imbibe coloring matters." And in illustration of the fact, a special instance is noted, as follows:

"Fishing nets are usually boiled with oak bark or other like astringents, which render them more lasting. Those made of flax receive from

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[1] "Philosophy of Permanent Colors," 1, 227, of the Philadelphia edition of 1814.

[2] See, for example, The Rural New Yorker, January 31, 1880, p. 80, and May 14, 1881, p. 327; also, The Cultivator and Country Gentleman (Albany), 1880, **45**, 431.

[3] The chemical works of Casper Neumann, abridged by Wm. Lewis, London, 1759, p. 429 note.

this decoction a brownish color, which, by the repeated alternations of water and air, is in a little time discharged, whilst the fine glossy brown communicated by the same means to silken nets permanently resists both the air and the water, and stands as long as the animal filaments themselves."

Tannin of one kind or another is actually employed by dyers, not so much, perhaps, for the sake of the color it imparts by itself, as that it serves as a mordant to fix colors on cotton and flax, which could not otherwise be so well employed on these kinds of fibers. Crace Calvert,[1] for example, says of sumac that it is largely used in Yorkshire to mordant the cotton warps of mixed goods. By means of it the cotton takes the same colors as the woolen weft with vegetable dye-stuffs and with aniline colors. But it is particularly under the influence of weak alkalies that the tannins combine with vegetable fibers, and that they absorb oxygen, turn brown, and become fixed upon the cloth. As Calvert has said, on p. 311 of the work just cited, all the tannins are remarkable for the avidity with which they absorb oxygen in presence of alkalies, being converted into bodies of various colors, green, red, brown, and black.

I find, on investigation, that methods of dyeing depending on the action of alkalies upon tannin have long been in familiar domestic use in this country; the bark of the maple, alder, chestnut, walnut, and butternut, and doubtless of other trees, being used in different localities, as well as the husks of several kinds of nuts. For example, L. Stanley, of Maine,[2] directs: "To color brown, make a dye of common alder bark. First dip the articles in this, then wring them out and dip them into weak lye. This will make the color light or dark, according to the strength of the alder dye. It is a fast color." In the American Agriculturist for January, 1869, two or three receipts for dyeing tan-color are given. In general, the directions are to boil black-walnut hulls to a strong liquor, into which either cotton or woolen yarn may be put and boiled for ten minutes. The yarn is then taken out and dipped in a pail of strong lime-water, and the operation repeated until the color suits; or, instead of the hulls, chestnut or walnut bark may be used, or extract of hemlock bark.[3] According to Porcher,[4] "the inner bark of the short-leaved pine (*P. tæda*) will dye cotton goods a brown color without the aid of copperas. After boiling in the solution, dip in strong lye." I have heard of alder bark and soft soap being used in domestic dyeing in Nova Scotia for coloring linen tan-color; and it is plain that the soap would exert an alkaline action in this case, even if it served no other purpose. It appears from all this that while tan liquor alone is undoubtedly used in some localities for staining canvas and twine, there are

[1] "Dyeing and Calico Printing," Manchester, 1876, p. 326.

[2] American Agriculturist, February, 1867, **26**, 48.

[3] American Agriculturist, November, 1868, p. 401.

[4] "Resources of the Southern Fields and Forests," p. 585; cf. pp. 215 and 217.

other places where the people are familiar with a true process of dyeing, dependent upon the use of alkalies in conjunction with decoctions of astringent barks. As will be seen directly, I have discovered one locality where the last-named system is said to be applied to the coloring of sails and nets.

After having been for forty years accustomed to the sight of tanned sails, and familiar with the sailor's belief that they are simply tanned as leather is, but without ever having been thrown into intimate contact with people who use tanned sails, I had the curiosity in the summer of 1882 to ask a very intelligent fisherman on the New Brunswick coast how his comrades colored their sails, and was not a little surprised on being told of processes which, when chemically considered, mark a distinct advance on the traditional system of simple soaking in tan liquor. The New Brunswicker told me that his people boil the bark of spruce or fir trees in water for many hours, and finally decant the cooled liquor into a tub, where it is mixed with soft soap or with saleratus, and the sail (either hemp or cotton) is put to soak in the mixture for a couple of days. He maintained that sails thus tanned last two years longer than those not tanned, while for nets the process is deemed to be well-nigh indispensable. On my asking whether they didn't use oil with the saleratus, he answered that they did; and it was this reference to the use of oil and alkali which excited my interest in the subject, and led me to search for testimony which should corroborate his statement. It is evident from what has gone before, that in so far as relates to the use of alkalies with the tan liquor, the statements of the New Brunswick fisherman are fully supported. I have found evidence that both "lye" and soft soap are familiarly used as adjuncts to dyeing with barks, and it is well known that the conjoined use of tannin and alkali is an approved mode of operating which has long been habitual, in one form or another, in dye-houses. I have been assured, moreover, that soft soap is used in some Nova Scotian households in dyeing wool with cudbear, "to set the color and change its shade," which goes to show a practical familiarity with the use of this agent in coloring processes.

It should be explicitly said, perhaps, that I have not the least doubt that my informant was a thoroughly trustworthy person. I fully accept his statements as to the use of saleratus and soap; though of course he may have failed, and probably did fail, to correctly state certain details of the process as to ageing, dipping, and drying; but it will be noticed that in our conversation the word "oil" was first suggested by myself, and there is unquestionably a certain risk that we may have misunderstood one another in respect to this particular item. If oil is really used, as he said it was, in the process of coloring sails, the fact is one of no little interest in its archæological bearings; it would be an important contribution to the history of chemical technology, for, considered merely as a method of dyeing, the process would then be essentially

identical with the famous old East Indian method of fixing a fast red on cotton by means of madder (or its equivalent) and an oil mordant: I mean the color known to the English as Turkey-red, and to the French as *rouge d'Andrinople.* The East Indian process, as described by the earlier investigators, is as follows:

"For dyeing cotton, the Hindoos prepare an imperfect soap from oil, ashes, and animal matters. More precisely, they soak the skeins in a soapy liquor made with goat dung, oil (of stated kinds), and potash lye, obtained by leaching the ashes of certain plants; then they expose the cotton to sun and air for several days, and finally dye it with chay root (equivalent to madder), without applying previously to the cotton any alum or acid or saline matter."[1]

To my own mind, the verisimilitude, or, so to say, the chemical reasonableness, of the story as related to me by the New Brunswick fisherman lent strength to it, and I would have been glad to have found recorded evidence to support it, but as has been seen already, I have practically failed to do so. It is to be noticed, meanwhile, that the soft soap employed by the New Brunswickers would naturally be of home manufacture and incompletely finished. It would be likely to contain of itself much of the emulsion of oil and alkali so useful in Turkey-red dyeing. The probabilities are strong withal that the soap is made from a more or less rancid fish-oil such as Pallas[2] found in use among the Armenian dyers of Turkey-red at Astrachan, and such as in more recent times has been approved an efficient agent by the Turkey-red dyers of Manchester.

In case it should turn out to be true that sails and nets are anywhere colored by means of an oil mordant, it will be of special interest to ascertain how long the process has been in use in the locality, and whence it came thither. It seems highly improbable that the method should have been copied either in America or Great Britain from the Turkey-red dyers, for it is only in recent times, comparatively speaking, that the process of dyeing Turkey-red has been practised by the Western nations. It was not until the middle of the eighteenth century that it was successfully employed in France.[3] Mention is made of it as being employed in 1765 in Great Britain, and it is admitted that the art has been successfully practiced there since 1785.[4] The details of the Turkey-red process, as imported to civilized Europe, were so tedious and complicated, and the scientific explanation of them was so little understood, that there is hardly the least likelihood that any feature of the process could have been transmitted by professional dyers to European and American fishermen or housewives in recent times. The very crudeness of the domestic processes above-mentioned would of it-

[1] Mazeas, Memoires des Savans étrangèrs, 1763, **4**, 15–18.

[2] Cited by Berthollet, Elemens de l'Art de la Teinture, **2**, 161.

[3] Ure, Dict. Arts, **2**, 90.

[4] McPherson's Annals of Commerce, **3**, 433, and **4**, 95.

self indicate that they have not been derived from any modern dye-house. It seems far more probable that the tanning process might have originated in a primitive state of society, where the oil mordant may have been used familiarly, not only for red but for various other colors. It is in evidence that, though comparatively rarely used by the Western nations for fixing other colors than red, the oil mordant is perfectly competent to be used with a variety of other dyes besides madder and its congeners. Laugier[1] has dwelt upon the general applicability of the process for dyeing hemp, flax, and cotton. He finds it particularly applicable for yellows, for instance, as well as for reds. Beautiful shades of purple have been fixed upon cotton cloth by first mordanting with oil, as in the Turkey-red process, and then dyeing with aniline purple.[2] Indeed, the ordinary operation of "galling," employed incidentally in Turkey-red dyeing to strengthen and modify the red color, would be practically a dyeing of the cloth tan-color if it were pushed far enough. It is manifestly closely analogous to the dyeing of sails as described to me by the New Brunswick fisherman. It is known that under the influence of weak alkalies and dampness, galled cloth may absorb oxygen from the air and take on a brown color which is highly undesirable from the point of view of the Turkey-red dyers. Chaptal[3] stated the matter many years since: "The astringent principle of the nut-galls unites with the oil and forms a compound which darkens on drying and is but slightly soluble in water." "It is better to choose a dry time for the process of galling, because damp air blackens the astringent principle. After having been galled, the cotton cloth should be dried promptly, in order to avoid the blackening which would injure the brightness of the red the dyer wishes to obtain." Lewis[4] long ago tried experiments on fixing blacks by means of an oil mordant, using soft soap and following Mazeas's directions. He appears to have obtained a tolerably good fixation, though his colors were not handsome. The oil mordant was formerly sometimes used also for preparing a color known as "Swiss pink."

In some localities fishermen preserve their nets and sails by the combined use of bark (or catechu), tar, and oil (or grease), and the process has specially interested me as possibly having some bearing upon the question of an oil mordant just now discussed. Thus, in the Encyclopædia Britannica, article Fisheries, p. 248 (of the edition of 1879), it is stated that "barking" the sails is a regular practice with the trawlers, as it is with most other fishermen in England and Scotland. The process consists in mopping them over with a composition of a solution of

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[1] Dingler's Polytechnisches Journal, **47**, 278.

[2] Watt's Dictionary of Chemistry, **2**, 357; Reports by the Juries: International Exhibition of 1862, Class XXIII, p. 3. It is to be hoped that the yachtsman who may set topsails of this superb color and strive to carry them to the forefront will gain a more worthy renown than did his prototype at Actium.

[3] Memoires de l'Institut (An. VII), **2**, 291, 292.

[4] In his "Philosophical Commerce of the Arts," London, 1763, **2**, 431.

oak bark, tar, grease, and ochre, which acts as a good preservative of the canvas. This is done once in six or eight weeks, and a suitable place is kept for the purpose at all the important fishing stations. Capt. J. W. Collins[1] states that to preserve their nets, the Newfoundland cod fishermen make a mixture of tan and tar, which is thought better than either used separately. The tan is made from spruce buds, fir bark, and birch bark (hemlock bark is not used), which are boiled together until it is sufficiently strong, when the bark is removed and tar added in the proportion of 5 gallons tar to 200 gallons tan, the whole being stirred well together. Some care is necessary in applying this, or else it will not be evenly distributed on the net. The custom of mixing tan and tar has doubtless been introduced from England, as it is known that the Cornish fishermen do this, pouring out their tanning liquor into large vats with coal tar, and this mixture is found to preserve the nets much longer than simple tanning. The Newfoundland nets, when prepared in this manner, generally last about four seasons.

Something similar is done by the Irish fishermen from Galway, a colony of whom have for a number of years been settled here at South Boston. I have received information from three different individuals with regard to the methods employed. The first witness assured a friend of mine that his people use "catechu, grease, and tar, to color their sails." He had, for his own part, forsaken the traditional practice, and "would not himself put such stuff on a white sail." Some time afterward I had an opportunity to talk with an intelligent Galway woman, a domestic in a friend's house. I quote her words: "First they take the clean cloth. Then it is all white. Then they get some kind of oil, I don't know what, and get it all over the cloth, and then they hang it up to dry for a long while—a week or two weeks—and then the cloth is yellow, and then they put the oil on it again, and hang it up to dry again—and I don't know what they do after that." I was careful not to ask any leading question, and made no effort to help on the story. She knew very well that the sails were almost black finally, but could not tell what made them black. Still later this same woman obtained the following account from the mouth of an old Galway fisherman. Take 3 gallons of tar and 20 pounds of fresh butter. Melt the butter in a vessel, and add to it a cup of salt. If salt butter were used there would be no need of the salt. Heat the tar almost to boiling in another vessel, and slowly add to it the butter, constantly stirring meanwhile. When the two are thoroughly combined the mixture is applied to the sailcloth by the hands of the fishermen; generally six fishermen on each side of the sail. The rubbing-in by hand is deemed to be all-important, and it is commonly done in the early morning of a fine day, and the sail exposed to the sun, in order that the mixture may be dried in. In good sunshiny weather the drying process is completed by sundown. At the end of a week another coating is given in the same manner, and after a couple of days

[1] Bulletin of the U. S. Fish Commission, 1881, p. 7.

the sail is fit for use. The quantity of tar and butter above given is sufficient for one of their fishing boats, which are some 6 or 8 tons burden. Great importance is attached both to the rubbing-in and the drying. In connection with these stories I could but recall the fact that the old French name of tarred cloth was *toile grasse.*

In this category may be mentioned the Dutch method of tanning cotton herring nets, as described by Captain Collins,[1] and stated by him to be "thought better than any other by these foreign fishermen." The tan is made by boiling catechu in water, in the proportion of 1 pound of the former to $2\frac{1}{2}$ gallons of the latter. When it is sufficiently strong the nets are soaked in it twenty-four hours and then dried. They are tanned and dried three times, and then soaked in linseed oil. A pound of oil is provided for each pound of net, and the nets are allowed to remain in the oil as long as any of it will be absorbed. They are then well drained and spread on the ground to dry, after which the process is completed by tanning them once more. Nall[2] says a strong three-twist cotton cord procured from Musselburgh has lately been introduced as an experiment. It is prepared by steeping in a mixture of linseed oil and varnish, and is then squeezed through rollers. This renders it stiff and smooth as wire when dried. It is afterwards subjected to the tanning process. In addition to hempen twine, a coarse Persian silk was employed in the netting used in the Dutch fisheries of the seventeenth century, as more durable. It was slightly pitched or exposed to the smoke of burning ash to acquire a dark color and render it less perceptible by the fish.

There is a process of varnishing the silken lines used by pleasure fishermen for the purpose of keeping them dry and reelable that differs from the foregoing. As described by de la Blanchère, in his Dictionary, page 765, the lines may either be boiled in a drying oil, or, better, a small quantity of drying oil with which some white and green paint has been mixed may be carefully rubbed upon and into the stretched line. A second coating of the varnish is laid on when the first has become dry, and the operation is repeated at intervals until the wished-for stiffness and impermeability have been obtained. De la Blanchère remarks, also, that nets are sometimes treated with tars obtained from coal, and that the fishermen commend coal tar for this purpose in certain cases, in spite of the black color and the penetrating odor it imparts to the nets. John M. Mitchell[3] reports that Irish nets are most frequently tarred instead of being barked. Tarred nets, he says, are not so durable; in direct opposition to which statement I found a strong feeling at Provincetown in favor of tar, as being a much better preservative of nets than tan. Captain Atwood was decidedly of this opinion. Until the war of the rebellion his townspeople were accustomed to use pine

[1] Bulletin of U. S. Fish Commission, 1881, p. 8.

[2] In his "Great Yarmouth," &c., London, 1866, p. 291, and 290 note.

[3] In his book "The Herring," Edinburgh, 1864, p. 99.

tar from the South; it was only when their supply of the material was cut off that they began to use coal tar.[1] One of the Nova Scotian fishermen with whom I talked about tanning nets laid a good deal of stress on the large amount of "gum" there was in the fir bark employed. Both he and Captain Atwood seemed to believe that this resinous matter played an important part in preserving the nets. The Boston manufacturer of nets previously alluded to said that his firm formerly used Wilmington tar, but now they used coal tar altogether. He urged that tar makes the net stronger; that it makes the twine more like wire; that it hardens the fibers and keeps them together so that the twine does not fray. He had heard of tar and oil being used together, linseed oil he supposed, and thought the purpose of the oil might be to soften the tar. He remarked on having no facilities for drying (ageing) the tarred nets in his Boston warehouse, and dwelt upon the fact that freshly tarred nets are liable to "heat" and spoil. To prevent them from suffering injury in this way it is customary to soak them in brine. Moreover, when tarred nets are done up into bales salt is scattered upon each layer of netting to hinder the package from heating. It appears that it is now customary with the fishermen on the New England coast to regularly salt down their nets when they are stowed away at the end of the fishing season. In warm weather also the mackerel fishermen are at pains to strew salt upon their nets, layer by layer, when they stow them, even for brief periods, in the seine boats; the idea being, of course, in this case to check the putrefaction of the slime and gurry with which the nets are soiled.[2]

As to other methods of protecting sails from mildew, I learn that burnettizing (*i. e.*, the use of a dilute aqueous solution of chloride of zinc) is sometimes practiced in this vicinity. I was assured by the captain of a sea-going schooner that once when a suit of his vessel's sails seemed ruined with mildew he had them dipped, with the result that they came out white and clean, and wore well for three years. One practice is to spread out the sails of small vessels on a beach and wash them over with a mixture of whitewash and brine. Some people appear to use plain whitewash. An objection is urged, however, to the use of lime that it tends to rot the canvas, and there is probably some risk that in

[1] It is noticeable that our fishermen habitually put an extra allowance of tar on cordage that is to be kept under water. The cables of Bank fishermen, whether made of hemp or of manilla hemp, are commonly thoroughly tarred, and so are the buoy ropes of lobster pots and of sunken moorings.

[2] The modicum of the truth in the old conception that "putrescent bodies exert an action on complex organizations which by themselves are not putrescent," is well illustrated by a case like this. A parcel of microdemes having established a satisfactory residence upon the animal matter with which a net is soiled, soon find the cellulose of the twine a useful addition to their food. It serves in some sort as a diluent of the highly nitrogenized ration which the slime supplies. In other words, some of the constituents of the cellulose of the fiber are involved in the reactions which occur during the fermentation, and the integrity of the twine suffers accordingly.

seeking to destroy the mildew fungus with alkalies, the growth of forms favorable for putrefaction may be promoted. To quote from Duclaux:[1]

"Acid liquids are in general more favorable to molds, to yeasts, and to mycoderms; it is only very exceptionally and only *en passant* that mobile forms are found in them, *i. e.*, vibrios, bacteria, or monads. These kinds appear, on the contrary, by preference, in neutral or alkaline liquids, where the molds for their part have much trouble to live. The mold Aspergillus, for example, grows freely on bread moistened with vinegar, on the juice of lemon or slices of lemon, and on sour fruits and liquors."

I find a common impression that the sizing in new canvas attracts mildew, *i. e.*, that the mildew fungus finds a fit field for its support in the sizing which has been introduced into the interstices of the canvas at the factory. To avoid this difficulty some owners of vessels prefer to bend their new sails in the autumn in order that the sizing may be "worked out" of the canvas by the autumn and winter rains, at a time, that is to say, when the weather is too cold for mildew to prosper. Old sails are said to be comparatively exempt from mildew. The time-honored and universal custom of shaking out or hoisting sails in order that they may dry after rain is one familiar method of preservation. It is precisely because drying is frequently impracticable in some climates that the tanning process is practised.

It would be well to study practically whether the method of permanently dyeing sails, either with the aid of an alkali or by means of an oil mordant, is really an effective means of shielding the canvas from the mildew fungus; and it would be of interest to determine whether the altered and oxidized oil that constitutes the mordant in Turkey-red dyeing might not of itself help to preserve sails, even if no tanning or other coloring substance were combined with it. This last question could perhaps be answered at once, even now, by persons who have had experience with the use of Turkey-red cloths in damp situations. It is not unfair to suppose that the oil mordant might be useful of itself, since it would probably tend to keep the sails drier than they would be in its absence; and in this way it might be obnoxious to the fungi, which need moisture in order that they may thrive. So too with cordage; it might be questioned whether ropes made from hemp that has been impregnated with the oil mordant (and tannin), instead of with tar, would not be specially serviceable in some cases.

NOTE.—Since the foregoing article was written, several friends have described to me a method of coloring sails, practised in the vicinity of Venice, which differs essentially, both as to motive and procedure, from the processes of tanning and tarring above described. It appears that, far from dyeing or tanning their canvas, the fishermen at Chioggia merely mix earthy pigments, such as burnt sienna and yellow ochre,

[1] E. Duclaux, "Ferments et Maladies," Paris, 1882, pp. 43, 45, 50.

with salt water; rub the mixture upon their sails with a sponge, and let the coating dry in the sun. That is to say, they paint the sails with water colors, and as soon as the paint wears thin they smear on a new coating of it.

Apparently, the purpose of this application, nowadays, is purely decorative. At all events, the practise calls to mind certain historical instances, such as the purple sail of Cleopatra's galley, already alluded to; the fact that Alexander had sails of various colors, to distinguish the several divisions of his fleet; and that the English King Henry, in 1416, had a sail of purple silk on his particular ship. But as regards the Italians, it seems not improbable that there may have been some use formerly in making the sails dark-colored, in order the more readily to escape the observation of the pirates which infested the Mediterranean until a comparatively recent date. It is hardly probable that earthy pigments applied in the manner above stated can be of much, if any, use for preserving the sails. On the contrary, the question naturally arises, may not the earths sometimes actually injure the canvas in the same way that iron-rust is known to corrode sails, as well as other vegetable matters, by continually giving up oxygen to them while it takes up new oxygen from the air. I remember to have myself met, many years ago, with American fishermen who were very averse to having any kind of "dirt" get on their sails "because it rotted them."

It has been suggested to me that the Italian fishermen may possibly use the pigments in order to close the pores of the canvas so that the sails may hold the wind better. But if this be so why do they employ a process of application that requires to be frequently repeated? why do they not put on the pigments in such manner that they may stay?—F. H. STORER.

BUSSEY INSTITUTION (OF HARVARD UNIVERSITY),

August, 1883.

APPENDIX C.

NATURAL HISTORY AND BIOLOGICAL RESEARCH.

XIII.—NOTES ON THE HABITS AND METHODS OF CAPTURE OF VARIOUS SPECIES OF SEA BIRDS THAT OCCUR ON THE FISHING BANKS OFF THE EASTERN COAST OF NORTH AMERICA, AND WHICH ARE USED AS BAIT FOR CATCHING CODFISH BY NEW ENGLAND FISHERMEN.

BY CAPT. J. W. COLLINS.

INTRODUCTORY NOTE.

For many years after the introduction of trawl-line fishing in New England birds were extensively used for bait to eke out the supply obtained from other sources, and even prior to the time when trawls came into use old fishermen say that they caught birds on the banks with which they baited their hand-lines. Several varieties of birds were obtained for bait, principal among which may be mentioned the hagdons (*Puffinus major* and *P. fuliginosus*); the jægers, of several species; fulmars, gulls, and petrels or Mother Carey chickens.

Birds were used much more extensively before 1875 than they have been since, as of late years it has generally been found more profitable to depend on other sources for a bait supply. They have never been used for bait in any great numbers, except by trawling schooners on the Grand Bank, and these vessels were said to be engaged in "shack-fishing."

The term "shack-fishing," it may be explained, owes its origin to the kind of material used as bait, the word "shack" being applied to refuse or offal. The vessels procuring fares in this manner were called "shack-fishermen." They usually resorted to the Banks in early spring, carrying a limited amount of salt clams, salt squid, or menhaden slivers, which were intended to be used in commencing the fishing season, and to eke out any deficiency which might occur in the bait supply. The fishing being well under way, the crews depended upon such bait as they could procure on the Banks, such as birds, small halibut, porpoises, and sometimes codfish; all of which, together with the contents of the stomachs of the cod, which often consisted largely of bank clams and occasionally young squid and capelin, were called "shack," or "shack bait."

A fisherman preparing a bird for shack-bait cuts off the feet, tail, and neck; then, making a cut across the breast, he strips off the skin and

throws it overboard. Having removed the skins and viscera (the latter makes an excellent bait) from as many birds as he has at hand, he pounds the bodies with the back of a heavy knife or stick, breaking the bones, or, as he would term it, "mummies them up." This beaten and bruised mass of flesh and bones is then cut up into small pieces of suitable sizes to be used as bait. At this point the fisherman is influenced by the number of birds he has on hand. Should the supply be bountiful, he divides the bodies into comparatively large sections, while, on the other hand, if the birds are scarce, he must exercise the strictest economy, and subdivides the material into correspondingly small pieces, large enough only to "point the hooks," while an inferior and less desirable bait may be used on the shanks.

On some parts of the Grand Bank cod are found in great abundance, and the clams taken from the "pokes" (stomachs) often furnish a considerable percentage of the requisite amount of bait for the trip. The roes of the cod, when partially developed, are also used as bait, since they make a fairly attractive lure, and if properly attached to the hooks cannot be easily pulled off by the fish. When this bait is used the "pea" is cut into strips in such a manner that they may be turned inside out; the hook is then passed through and through the membraneous covering in several places, a turn being made around the shank each time.

Shack-fishing differs from other styles of Bank fishing only in the method of obtaining bait supplies. A vessel engaged in shack-fishing remains on the Bank until she has secured her fare, and, as before stated, depends solely upon getting her bait on the ground instead of—as is the custom of other vessels—leaving the Bank and running into the harbors of Newfoundland and Nova Scotia to obtain a "baiting" of herring, capelin, or squid.

The method of shack-fishing has its advantages and disadvantages. One of the advantages, and a very important one, is that no time is lost in seeking bait, and the vessel is enabled to prosecute her fishing on the bank whenever favorable days occur. On the other hand it must be acknowledged that the kind of bait employed by the shack-fishermen is comparatively unattractive to the fish, and the supply oftentimes has of late years been inadequate; consequently, it has generally been found more profitable for our bankers to obtain supplies of fresh bait in the provincial ports. At the present shack-fishing is rarely undertaken. It may be worthy of mention, however, to state that fine fares of cod have been obtained by this method as late as 1874–'75, and, indeed, this mode of capture has, since then, sometimes been preferred by the most experienced fishermen, especially when cod have been extremely abundant on the Banks; for when a large school of fish is around a vessel a fisherman is very reluctant to heave in cable and fill away, even for a "fresh baiting."

As birds were considered as good or better than any other kind of

shack bait, and as they could often be taken in large numbers, it will readily be understood their presence on the fishing banks often was of material aid to the fishermen in securing their fares of cod.

In these notes the writer expects to do nothing more than to give, in an off-hand, and, perhaps, rather disconnected manner, the result of his study of the habits and methods of capture of these sea birds, which for many years were his almost daily companions; the chief object being, of course, to convey some idea of the importance of several species as a source of bait supply to our fishermen.

THE GREAT SHEARWATER, (*Puffinus major*).*

This species, the "hagdon," or "hag," of the fishermen is, perhaps, one of the most interesting which is to be found on the outer fishing-grounds; it is used for bait more than any other bird, and has many peculiarities essentially its own. It has a wide distribution in the western Atlantic, and I have myself observed it all the way from latitude 39° 50′ N., longitude 71° 25′ W., to north of the Grand Bank in latitude 47°, longitude 50°.† The place of its greatest abundance, however, is probably from near Le Have Bank to, and including, the Grand Bank, the latter locality seemingly being its favorite resort during the summer season. There it occurs in remarkable numbers for several months of the year; indeed, so abundant is the species that, in many cases, as will be shown further on, it has become of considerable importance as a source of bait supply for the cod-fishermen on that bank. It appears on the fishing-ground usually in the latter part of May or about the 1st of June. In a daily journal kept by myself I find the following note, under date of May 26, 1879: "I saw a hag this morning, the first I have seen this spring."‡ This bird was probably a straggler from the large flocks, and very likely it reached the fishing-ground sooner than its companions. Three days later, however, on May 29, when in latitude 43° 35′ N., and longitude 59° 47′ W., I saw several large flocks of these birds, and shot one individual. The birds were at that time sitting on the water, and had apparently just reached the locality. Their stay on the Banks continues until about the middle or last of October (occasionally later), when they gather in flocks, sitting around on the water for a few days before taking their departure.

Occasionally, in midsummer, they seem to be scarce, but what the

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* It is altogether possible, perhaps probable, that there may be other species of *Puffinus* which frequent the fishing banks, besides the two I have named in these notes. On several occasions I have seen birds of this genus which were much smaller than *P. major*, and which I then thought were the young of that species, but I now believe they were a smaller variety. My object, however, is not to define the species, but simply to give some idea of the habits of the birds.

† Mr. Ridgway tells me that *P. major* is found as far south as Cape Horn or vicinity.

‡ Our position at that time was latitude 43° 10′; longitude 62° 23′.

cause of this scarcity is I am unable to say. Under date of August 1, 1879, I find the following note: "Shot three hags, but they are very scarce." I am somewhat inclined to the opinion that they find abundance of squid at that season, and therefore do not come about the vessels so much as when hungry. When or where the hagdon breeds is unknown to me. My opinion is that it breeds in winter. I have opened many hundreds of these birds, but have never found their sexual organs in a condition that would indicate they were incubating.

It may be well, in this connection, to allude to the social habits of the hagdon as they have come under my observation. When the birds reach their destination in the spring, for a few days after their arrival, they do not seem to make any special effort for the purpose of securing food, but pass most of their time sitting in large numbers on the water, and at this period it is somewhat difficult to catch them on hook and line. Occasionally a flock will make a short flight and again settle down, but there appears to be a strong inclination, at this time, to huddle together and keep up the organization which has probably existed during their migration from distant regions. The same thing in regard to going in flocks is noticeable in the fall, when they collect for their autumnal migration from the fishing-banks. At such times they show the same disinclination to bite at hook and line that they exhibit when first arriving on the fishing-grounds. This apparent indifference to food at such times is all the more remarkable, since only a few days elapse after the flocks have reached the fishing-grounds in the spring before they break up; and in a little while after the arrival of the hagdon it may be seen skimming the surface of the water on a tireless wing, totally unmindful of the presence or absence of its companions, unless, indeed, their appearance may indicate where food is abundant; in such cases it loses no time, but rapidly wings its way to join them in the feast. Nor does it do this from any feeling of sociability, if we may judge from its actions, but simply to gratify its enormous appetite. In doing this it fights and struggles with all other birds, whether of its own kind or of other species, to gain possession of the finest morsels, uttering, meanwhile, extremely harsh and discordant notes. When feeding it displays a dash and pugnacity that is perfectly astonishing. The audacious boldness with which it will attack superior strength in the struggle for food, and the ferocity and reckless bravery it exhibits on such occasions cannot fail to command the attention of all who witness the performance. Nothing can exceed the activity of the hag or its intrepid recklessness, if I may so term it, when in pursuit of food, and, when very hungry, it seems to pay almost as little regard to the presence of man as to the proximity of other birds.

The tenacity of life exhibited by *Puffinus* is certainly surprising. It often happens that after its skull has been crushed between the teeth of its captors, a hagdon may lie seemingly dead for several minutes and then recover sufficiently to make desperate efforts to escape. In several

instances which I can recall, hags that were thought to be dead have escaped by "flopping" out over the slanting stern of the dory, unnoticed by the fishermen until it was too late to recover the wounded birds.

The tenacity of life and the remarkable pugnacity of these birds have, upon many occasions, provoked the fishermen to the cruel sport of tormenting them and prolonging their sufferings. Perhaps a dozen or more hags may be caught, and having been put in a hogshead-tub, or in a "gurry-pen," on the deck of the vessel, the fishermen bring about an internecine war by stirring them up with a stick. At such times the birds evidently imagine that their companions are avowed enemies, and, pitching into their nearest neighbors, a general fight and terrible commotion ensue, while the feathers fly in all directions, much to the amusement of the men. In a short time the birds which were taken from the water sleek and strong, are utterly worn out in their struggles with one another, and present a bedraggled, forsaken, and disreputable appearance. The fishermen also sometimes tie two hags by the legs, using a string about one foot in length, which enables the birds to swim, but keeps them in unpleasant contact, the consequence being that they fight until one or both succumb.

The hagdon is remarkably strong and swift in its flight. Often it may be seen skimming over the waves, passing from the top of one sea to another, scarcely moving a muscle; but by trimming its wings, if such an expression is allowable, first poised on one wing and then on the other, it is apparently propelled without an effort on its part, but simply by the action of the wind beneath. This method of flight, however, is frequently varied, for when necessary the hagdon can and does move its wings with great power and considerable rapidity. When in pursuit of food it plunges suddenly down into the water, striking on its breast with great violence, and in a manner quite different from that in which gulls alight. Its method of diving is also different from that of many other species. It never plunges head first into the water as do the gannet, kingfisher, and many other piscivorous birds; but it first alights upon the surface, as just noted, disappearing almost instantly. It is an active swimmer under water, and when in pursuit of food passes rapidly from one object to another, provided it cannot eat the first thing which attracts its attention. When the hagdon finds food agreeable to its taste, it immediately rises to the surface and hastily swallows the morsel, if it is not too large. This manner of eating is necessary as a matter of self-protection, for if the bird delays swallowing its food, it will soon have to dispute its right of possession with its companions.

It is a common occurrence for a number of these birds to chase a boat for half an hour or more at a time, diving like a flash, every few minutes, after the bubbles made by the oars, which these winged rangers seem to imagine some kind of food beneath the surface of the water. Nor will repeated failures discourage them in making these attempts. They will also persistently follow a dory from which a trawl is being

set, and diving in the wake of the boat, after the sinking gear, make desperate endeavors to tear the bait from the hooks. In these attempts they are often successful, much to the chagrin of the fishermen whose chances for catching fish are thus materially diminished by these daring robbers.*

The voracity and fearlessness which are thus so strikingly displayed by the hagdon offers the fishermen an opportunity to administer what they consider retributive justice, since the capture of these birds is thus made a comparatively easy task. Formerly, as has been stated, when shack-fishing was extensively carried on by the Grand Bank codfishermen, great numbers of *Puffinus* were caught for bait with hook and line. Before proceeding to describe the methods of capture I shall refer to the food of these birds. From my observations I am of the opinion that the hag subsists chiefly on squid, which, of course, it catches at or near the surface of the water. I have opened many hundreds of them, and have never, to my recollection, failed to find in their stomachs either portions of the squid, or, at least, squids' bills. It may be interesting also to mention the fact that in the fall of 1875, when the giant *Cephalopods*, or "big squid," were found on the eastern part of the Grand Bank between the parallels 44° and 45° north latitude, and the meridians of 49° 30′ and 50° 30′ west longitude, flocks of hagdons were invariably found feeding on the dead "devil-fish" which were floating on the water. In nearly all cases these "big squid" were found in a mutilated condition, usually with their tentacles eaten off almost to their heads, and the fishermen soon learned to detect their presence by the large flocks of birds collected about them. The small species of fish which frequent the waters of the eastern fishing-banks, such as the lant, capelin, etc., also furnish *Puffinus* with a portion of its food. But birds of this species, as well as most all others found at sea, are excessively fond of oily food, and especially the livers of the *Gadidæ*, cod, hake, etc., and this extreme fondness for codfish livers, which they swallow with great avidity, renders their capture possible by the fishermen with hook and line. "Hag-fishing," as it is called, can be carried on either from the side of a schooner or from dories, though usually better results are obtained by the men going out in the latter at some distance from the vessel. When it is desirable to obtain these birds for bait the morning is usually selected to effect their capture, since at that time they are generally more eager for food than later in the day, when they are frequently gorged with the offal thrown from the fishing vessels, or with food obtained from other sources. It is generally the case, therefore, that two men engaged in hauling a trawl in a dory, after having obtained a sufficient number of cod to supply them with the requisite amount of livers, stop

*My brother, Capt. D. E. Collins, tells me that on several occasions he distinctly recollects that hagdons were caught on trawn-lines belonging to his vessel, the hooks having fastened in the beak or throat of the greedy birds, which had swallowed the bait before they had torn it from the sinking gear.

hauling their gear and proceed to "toll" up the birds. In order to do this pieces of liver are thrown out, which immediately entice the ever-present petrels or Mother Carey chickens that gather in flocks around the floating morsels and dancing up and down upon the water, tear the swimming particles into pieces small enough for them to swallow. If the weather is clear the keen eye of the nearest hagdon quickly detects this gathering of small birds near the boat, and thither he wends his way to scatter the little Mother Carey chickens right and left by his audacious aggression, while he swallows, with indescribable eagerness, the pieces of floating liver, uttering, meanwhile, his harsh and disagreeable note. Not many minutes elapse before other birds—hagdons, jægers, and other species, perhaps—may be seen coming from all points of the compass, and in a short time a large flock collect about the boat. If the weather is thick the programme is slightly varied. The birds are then attracted by the fishermen imitating their cries, and also, perhaps, by their scenting the oily liver floating on the waves. I am assured by an excellent authority—Dr. Elliott Coues—that all the birds of this family are provided with very imperfect organs of smell; but, nevertheless, both the hag and the Mother Carey chicken exhibit some peculiarities which so strongly resemble those of a dog working up a scent that it may not be out of place to call attention to the subject here. On many occasions, during the prevalence of a dense fog, when not a bird of any kind had been seen for hours, I have thrown out, as an experiment, pieces of liver to ascertain if any birds could be attracted to the side of the vessel. As the particles of liver floated away, going slowly astern of the schooner, only a short time would pass before either a Mother Carey chicken or a hag, generally the former, could be seen coming up from the leeward out of the fog, flying backward and forward across the vessel's wake, seemingly working up the scent until the floating pieces of liver were reached. If the first bird to arrive should be a Mother Carey chicken, and the liver too large for it to attack alone, which was generally the case, the petrel would at once fly away, and in a few minutes three or four could be seen returning. This suggests a question as to whether the petrel went to seek assistance or not in order that he might share with his coadjutors the feast which he could not well obtain unassisted; but should the first one to appear be a hag he does not seek companionship, but with a greedy yell he pounces upon the pieces of liver and swallows them with the voracity characteristic of the species, and no sooner has he devoured one morsel than he is off on the wing seeking for more. However, it is generally the case that a flock of hagdons soon gather, whatever may be the density of the fog, unless birds are very rare on the Bank or, perhaps, rendered indifferent to food by a recent feast.

Having made this seemingly necessary digression to explain the methods of "tolling up" and gathering the flocks of birds about the dory, I shall now proceed to describe the *modus operandi* of their capture.

The two men in a dory, one aft and the other forward, are each pro-

vided with a line 5 or 6 fathoms in length, and a small hook, such as is ordinarily used for catching mackerel. The bait, consisting of pieces of codfish liver, is large enough to float the hook as well as to cover its point. The hooks are baited and thrown out as soon as a flock of hagdons have collected about the boat, and there also may be, and generally are, birds of other species. Should there be a large number of hags, and more especially if they have been without food for a short time, they display an almost indescribable voracity. In their eagerness to obtain the large pieces of liver, which they swallow at a gulp, as they fight among themselves, they do not seem to care whether a hook is concealed within the bait or not. At such times the birds may be easily caught, and are rapidly pulled in by the fishermen, who usually derive much gratification from the sport, not only from the excitement it affords, but also on account of the perspective profits which may result in obtaining a good supply of birds for bait. When a victim has been hooked, and is being pulled towards the boat, it struggles most energetically to make its escape by vainly endeavoring to rise in the air, or by spreading out its feet to hold itself back as much as possible as it is dragged unceremoniously over the water, while its vociferous companions follow after it, attempting to snatch away the piece of liver with which it has been decoyed. At times a bird may succeed in disengaging the hook from its beak, but usually the barbed point is well fastened and the hag is landed in the boat. A fisherman then places it under his left arm to prevent its struggles, and grasping the head of the unfortunate bird with his right hand he crushes its skull with his teeth. Or he may try to deprive his victim of life by wringing its neck, striking it on the head with a "gob stick," etc. This may continue until one hundred or perhaps two hundred birds are captured, but usually not so many. A comparatively short time passes before some of the birds become gorged with the pieces of liver which they have obtained, and then they exhibit the greatest cunning in eluding capture. They seem to be fully conscious of the fact that within the liver there is concealed something which, for their own good, they should avoid. With a wonderful instinct that almost approaches reason, they cautiously approach and take hold of the bait with the tips of their bills, and by flapping their wings, endeavor to tear it to pieces. In this maneuver the birds are often successful, and as a reward for their enterprise they secure a good lunch, which they hasten to devour, as the disappointed and disgruntled fisherman rebaits his hook with the hope of decoying some less wary individuals. It frequently happens, however, that a skillful "bait stealer" renders abortive all the attempts of the fishermen to effect its capture, while at the same time it will fight desperately with its intruding companions, to keep them away until it has filled itself to repletion. Having satiated itself until scarcely able to clear the water, it quietly drifts to leeward at a safe distance from the boat, floating upon the waves to await the digestion of its food, and apparently to

Hag fishing.

take in the situation. So greedy, however, are many of these birds that oftentimes they seem to leave, with great reluctance, the place where food is plentiful, even though they may be gorged to such an extent that they can eat no more. I have often, on such occasions, seen them lingering near the boats, looking upon a tempting piece of liver apparently with an expression indicative of regret that they could not find room for it. Frequently these greedy and garrulous birds also quarrel with their companions and attempt to drive them away from the food which they desire, but cannot accommodate. Of course their endeavors are futile, for while they are opposing one, others rush in and devour the liver.

When hags are abundant recruits are constantly arriving, and congregate in great numbers wherever food can be obtained. Eager to secure a share in the feast, the newcomers rush ravenously forward and swallow the pieces of liver, and are quickly pulled in by the fishermen, who, after killing them in the manner described, detach them from the hooks, and throw them in the bottom of the boat.

After awhile, however, the whole flock usually evinces a shyness which renders the sport unprofitable, and the men then employ themselves in hauling their trawls, or they go aboard the vessel.* If a sufficient quantity has been taken to more than supply the wants of the day, the birds are hung up around the booms and on the stern of the vessel. A few years ago it was not an unusual sight to see from two hundred to five hundred birds, more or less, of this species, suspended from a Grand-Banker. In this manner they may be kept for several days without becoming worthless for baiting purposes, and, if eviscerated, they will keep fresh a much longer time. Indeed, I am told that in the fall it has been a common custom for the Marblehead bankers to save quite a number of these birds and bring them home in a fresh condition from the Banks, the hagdons being simply eviscerated and hung up in the hold of the vessel.

These birds are eaten to some extent by the fishermen of the present day. Forty or fifty years ago, and even earlier, this species formed an important item in the bill of fare of a Grand Bank codfisherman. Al-

*It may be stated here that the capture of hagdons may occur at any time of the day and under different circumstances from those above mentioned; but the description given represents the most common method adopted. The birds are also often caught towards evening after the trawls have been set for the night, or from a dory paid astern of the schooner. In the former case, the men, after setting their gear, make their boat fast to the outer buoy of the trawl, and having enticed a flock of birds around their boat, they proceed to catch as many of the hagdons as is possible in the manner described. Ordinarily these birds are not caught to any great extent from vessels, except when the roughness of the weather renders it undesirable to go out in the dories, or when an unusually large and hungry flock has been collected alongside, attracted by the offal thrown out while dressing fish. At such times the men usually stand on both sides of the quarter-deck and catch the birds in the manner that has already been mentioned, except that wooden floats are occasionally attached to the lines a foot or two above the hook.

though they have rather a "fishy" flavor, which is not especially agreeable to a delicate palate, they are nevertheless, when properly cooked, an agreeable change for the table of a fisherman who has been absent from home several months, and, consequently, has not had an opportunity of obtaining fresh messes other than fish. At present, when our fishermen are enabled to get much better food than any other class of sea-faring men, hagdon "pot-pies" or "stews," are not so tempting to them as they were to the codfishermen of an earlier date. I am told by persons who have knowledge of the fact, that some of the old Marblehead fishermen who had been in the habit of eating the hagdon for many years, acquired such a taste for the peculiar flavor of the bird, that they actually preferred it to the domestic fowl; and when no longer able to engage in the bank-fisheries, would look to the younger men for their supplies of hags, which were brought home in the manner just referred to, on the Grand Bank vessels.

THE BLACK HAGDON, OR SOOTY SHEARWATER. (*Puffinus fuliginosus*).

The sooty shearwater, or the "black hagdon" of the fishermen, is invariably found with *Puffinus major*, and, doubtless, occurs over very nearly the same area. It is less plentiful on the fishing-banks, however, and, as a rough estimate, I should say that it does not exceed in abundance more than 1 per cent. of the numbers of the great shearwater. Its habits are very similar to those which I have mentioned as being peculiar to the common hagdon, and with the exception that possibly it is a little less noisy, the description of the habits of one species may be applied to the other. As the two species mingle freely together, the black hagdon is often captured with its less sooty companions, and is, of course, also used for bait by the "shack" fishermen.

THE FULMAR. (*Fulmarus glacialis*).

This species, known by a variety of names to the New England fishermen, such as "noddy," "marbleheader," and "oil bird"—called a "stinker" on the west coast—is found on the fishing banks north of Cape Cod in winter, and also occurs in greater or less abundance from Sable Island northwardly, during the summer months, though it is most numerous in this region during cold weather. The following notes from my journal, which were made while near the northwest part of the Grand Bank, may prove of interest in this connection:

February 7, 1879.—*On western edge of the Grand Bank*, latitude 44° 25′ N., longitude 52° 58′ W., "I saw several noddies this morning, but for some reason they would not come alongside of the vessel. I have seen one or more every day (since January 30), but have had no chance to get any."

February 8, 1879.—Same place as above. "Saw some noddies this morning and shot one, but did not get him."

March 11, 1879, in latitude 45° 9′, longitude 54° 58′, I shot four noddies, and the following entry is made in my journal under date of March 12: "There have been great numbers of noddies to-day. I shot two; but when the vessel swung into the trough of the sea I could not shoot any more."

"*March* 14. Have seen large numbers of noddies this trip, and almost every day since we have been here some of the burgomaster gulls—a large white species. I shot several of the noddies to-day, but the gulls are shy, and it is difficult to approach them near enough to obtain a shot."

I will add that the weather during the above-mentioned time was extremely cold. On April 13 of the same year I made the following note: "I have not seen a noddy this trip." We had then been at sea about one week. On April 18, 1879, we were on Green Bank, when the following entry was made: "I saw a noddy to-day for the first time this trip."

June 5, 1879. Eastern part of Banquereau. "I have noticed a noddy now and then for the last three days, but have not seen any before for some time."

Under date of July 29, 1879, the following entry is made: "I have seen no noddies this trip."*

The plumage of this species varies in color; that of some of the birds is of a uniform smoky gray, and of others white, with black wings, and some of the other feathers bluish.

The fulmars are probably more abundant on the Grand Bank than on any other of the fishing-grounds commonly resorted to by American vessels, with the exception, perhaps, of the halibut grounds in Davis Straits, or the Flemish Cap to the eastward of Grand Bank, which are not visited by many fishing schooners.

The marbleheader is quite as greedy as the hagdon, and quite as bold when in pursuit of food; but unlike the latter, which is always quarrelsome and noisy, the fulmar confines itself to a sort of chuckling sound, somewhat resembling a low grunt. It will swallow a piece of cod liver with even as great voracity as the hag, but it rarely, if ever, seems to exercise the cunning or caution of the latter in trying to avoid the hook, and, as a consequence, it is more easily captured. It is caught in the same manner as the hag, but owing to its comparatively small numbers on the fishing-grounds, the fishermen do not depend upon it so much as a source of bait supply as upon *Puffinus major*, since one would be likely to catch twenty, or perhaps many more, of the latter, to one noddy. When caught on a line and hauled into a boat it frequently emits quantities of oily matter from its nostrils, and often disgorges its food. This peculiarity of the species which is not common

* It may be offered as an explanation here that I was collecting these birds for scientific purposes, and, therefore, preferred to shoot them instead of catching them on a line.

to the hagdon, has been remarked by others. The hagdon will occasionally throw up the contents of its stomach when caught, but not as a rule, so far as I have been able to observe.

The fulmar subsists chiefly on small fishes, and, doubtless, participates with the hagdon in the pursuit of the squid; but I have no recollection of noticing in its stomach, as I have in that of the hag, the presence of pieces of squid or the beaks of that animal. I have, however, frequently observed that the contents of the stomachs of many of this species consisted almost entirely of small fish. Like *Puffinus*, it is very fond of oily food, which it swallows with astonishing greediness. It devours large quantities of codfish liver in a ravenous manner that would astound one unacquainted with its habits, and it certainly would tax their credulity to believe statements that might be made bearing on this subject.

The fulmar is essentially an Arctic bird and occurs in great abundance in the far North, where it is met with by whalers and halibut fishermen in summer, at which season, according to the accounts given by Arctic explorers, it goes there for the purpose of incubation.

"The fulmar is the constant companion of the whale-fisher," says Scoresby, in his Arctic Regions: "It is highly amusing to observe the voracity with which they seize the pieces of fat that fall in their way; the size and quantity of the pieces they take at a meal; the curious chuckling noise which, in their anxiety for dispatch, they always make, and the jealousy with which they view, and the boldness with which they attack any of this species that are engaged in devouring the finest morsels. The fulmar never dives but when incited to it by the appearance of a morsel of fat under water." These peculiarities of the species agree exactly with my own observations.

The fulmar has frequently a ragged appearance; the wings and tail-feathers being fagged out and the bird is often soiled with grease. They have a rank, pungent smell, which is exceedingly disagreeable. Notwithstanding its boldness when in pursuit of food, and its apparent indifference to the presence of man, frequently coming within a few feet of the side of a boat or vessel, rivaling in this respect the most daring feats of the hagdon, it is, nevertheless, entirely different from the latter so far as its pugnacity is concerned. Although it may struggle to get the food which another bird is trying to swallow, it does not exhibit such a fierce disposition as the hag, and when caught rarely attempts to bite. This is all the more strange since this bird has a sharp and very powerful hooked beak. Its flight is similar to that of *Puffinus*, and its manner of alighting on the water when in pursuit of food is also much the same. The noddy, however, as has been mentioned, rarely dives for food, and, so far as I have observed, goes but a short distance beneath the water, evincing, in this respect, far less activity and enterprise than the hagdon. It is never eaten by the fishermen; its disagreeable, repulsive odor rendering it undesirable as food.

It may be added here that Capt. Henry O. Smith, of Salem, Mass., tells me that the fulmar frequently occurs in considerable abundance in winter in Fortune Bay, Newfoundland, and he also says that on one occasion he killed one of these birds in that region, which had a half-swallowed herring in its beak, the fish being too large for the noddy to get down.

THE JÆGERS (*Stercorariidæ.*)

THE GREAT SKUA GULL (*Megalestris skua*).

This is known to the fishermen as the sea-hen, and is, perhaps, one of the most interesting species that occurs on the fishing-banks, owing to its comparative scarcity in natural history collections. It is by no means abundant on any of the fishing-grounds, but is, nevertheless, to be met with occasionally all the way from George's to the Grand Banks, at least, and, doubtless, has a much wider distribution. I have observed it from Nantucket Shoals to the eastern side of the Grand Banks. It is difficult to say when and where it occurs in the greatest abundance; but, so far as I am able to judge, I should say that it is most plentiful on the Grand Banks in July, August, and September. In the summer and autumn of 1874 I shot several specimens of this species which were used for bait, and I have also obtained it for a similar purpose on other occasions though it could rarely be taken by hook and line. I remember that it was more plentiful in 1874 than I have ever noticed it at any other time.

In this connection an incident may be mentioned which occurred that year, that shows in a remarkable manner the tenacity of life which this bird sometimes exhibits. I was out a short distance from the vessel in a dory for the purpose of shooting birds for bait. We were then engaged in shack-fishing, and it was necessary to obtain as much material as possible with which to bait our hooks. Among other birds flying around were several skua gulls, which, on account of their large size were more desirable than the smaller species. Having enticed one of them within gunshot, I fired at it, and knowing that I had taken good aim, I was very much astonished to see it fly away apparently uninjured. I watched it, however, and soon noticed that it did not move its wings, but seemed to have them fixed or rigid, and after going about half or three-quarters of a mile it fell into the water. I went in pursuit of it and without any trouble found it, lifeless on the surface. The most singular part of my narrative is that when the bird was cut up for bait by one of the crew, a single shot was found in the center of its heart.

These birds usually appear singly, in pairs, or at times three of them may be seen together, and it is very rarely that half a dozen or more are seen at the same time. They are very shy, and seem to avoid a vessel, but when exceedingly hungry they show less reluctance in ap-

proaching a boat. It is a rare occurrence to catch them with hook and line, owing to their timidity in approaching a vessel or boat, as well as to their precaution in swallowing the liver used as a bait; hence few are caught in this manner, and the bait is taken by some other less cautious and more active birds. It is generally not difficult, however, to attract them within gunshot of a boat, and during a gale they do not hesitate to seek food near vessels lying at anchor. Their flight, like that of other large gulls, is heavy and moderate; but I have seen them make swift dashes of flight when chasing smaller birds which had secured pieces of liver.

The following extracts from my journal may give an idea of the abundance of these birds as well as the seasons at which they occur on many of the fishing-grounds. It is my opinion, however, as previously stated, that they are more common on the Grand Banks than on any other fishing-grounds where I have noticed their presence, but since I began to keep notes of birds I have not visited the Grand Banks in the months when the skua is most likely to be seen there. The size of this species and the peculiar markings of its plumage renders it easy enough to distinguish it from any other bird found on the fishing-grounds; none could be mistaken for it unless it might be some of the jægers, and such a mistake could only be made by one who took little notice of the flight or size of the birds which came under his observation.

November 27, 1878. Latitude 42° 49′ N., longitude 62° 55′ W. Two skua gulls—sea-hens—came near the vessel. My gun-caps are damp and useless, therefore I could not get these birds, as they are shy and will not bite at a hook unless extremely hungry.

February 3, 1879. Latitude 44° 25′ N., longitude 52° 58′ W. Western part of Grand Banks—during a northwest gale saw a sea-hen which came near the vessel, but the wind blew too heavy to catch it on a line, and it was of no use to shoot it as it was impossible to pick it up.

June 2, 1879. Latitude 44° 36′ N., longitude 57° 12′ W. Saw a sea-hen (great skua) fly across our vessel's stern but it did not approach close enough for me to shoot it.

July 5, 1879. Latitude 44° 08′ N., longitude 59° 10′ W. Had a shot at a sea-hen which came near the vessel, but the sea was so rough from a recent gale that my aim was destroyed by the schooner rolling, therefore I failed to kill the bird.

October 11, 1883. While on a cruise in the U. S. Fish Commission steamship Albatross, and when the ship was just abreast of the Fishing Rip, Nantucket Shoals, steaming northwardly, a pair of great skuas passed across the vessel's bow, about 200 yards off, flying southwestwardly.

GULL-CHASERS (Genus *Stercorarius*).

There are several varieties of jægers, of the genus *Stercorarius* that frequent the fishing-banks, and which are known to the fishermen by

the names of "Marlingspikes," "Whiptails," etc.* The former term being generally applied to the larger species, and the latter name to those that are smaller, both appellations having a special reference to the two long central tail feathers which is a distinguishing feature of birds of these species. They usually are most abundant on the outer banks in spring and fall, are rarely seen in midwinter, and are comparatively scarce in midsummer. It is probable that in June and July the adult birds go in to the land to incubate. I do not recollect of having seen a single individual of the smaller species in winter, and these are always much less abundant than the larger varieties. The following extracts from notes in my journal on the appearance and abundance of these birds on the fishing-banks may perhaps be of interest. Before quoting these extracts, however, I will say that on the 29th of August, 1878, I sailed from Gloucester on a fresh halibut trip to Banquereau. On this occasion Mr. Raymond L. Newcomb† went with me, having been sent by Professor Baird to collect birds for the Smithsonian Institution.

When a few miles to the eastward of Thatcher's Island (Cape Ann) on the day of sailing, we saw several jægers of the more common varieties, most of them not having the long tail-feathers which are, generally speaking, the characteristic feature of these birds.

On September 3, some 20 miles eastward of Sable Island, Mr. Newcomb shot four jægers, besides birds of other species. September 5, we saw a number of birds belonging to the jæger family flying near the vessel, too far off, however, to shoot; but the following day a marlingspike was killed and added to the collection. On the 8th jægers were quite plenty, and three of the common varieties and a black one were killed. Two more marlingspikes and a whiptail were shot on the 9th, and an Arctic jæger was seen on the 10th, but kept too far off to be shot. A black jæger was killed on the 12th, which was the last of these birds obtained on the trip, as on that date we sailed for home. When a few miles west of Cape Ann, September 17, we saw a jæger engaged in a fight with two herring gulls.

The foregoing notes, together with the extracts that follow, cover about eleven months' time, nearly all of which I spent at sea on the fishing-banks, or in making passages to and from them. The presence of the

*The name of "Marlingspike" is generally applied to the larger species, such as the Pomarine Jæger (*S. pomatorhinus*) that was seen by Audubon at Labrador, and which is, perhaps, the most common species on the banks, and to Richardson's jæger (*S. parasiticus*), which, so far as my observations extends, is not very abundant on the northeastern banks, but is more commonly found in the Gulf of Maine. The Arctic Jæger (*S. buffoni*), which is much smaller than the other two species mentioned above, is called a "whiptail," because of the great length and flexibility of its two central tail feathers. This is said to occur in greater abundance farther north than it does on the Grand Banks and adjacent fishing-grounds, where it is comparatively scarce and always timid.

†The gentleman who afterwards went as naturalist on the ill-fated Jeannette, and who fortunately survived the hardships of the journey across the ice and up the Lena.

different kinds of sea birds was a matter of special interest to me, and their appearance or absence was carefully noted, therefore it is probable that a general idea may be formed, from a study of these notes, of the seasons when jægers are most abundant on the outer banks.

October 1, 1878.—Latitute 43° 54′ N., longitude 58° 32′ W., "I shot a hag and a marlingspike."

October 3, 1878.—"I skinned a marlingspike this morning, a hag and a gull. Later in the day I shot three gulls and two jægers."

October 4, 1878.—"Shot a black marlingspike to-day, and skinned one of the more common varieties."*

November 13, 1878.—On Le Have Ridges, latitude 42° 49′ N., longitude 62° 55′ W. "Skinned four birds—three gulls and one jæger."

April 13, 1879.—East end of Banquereau, latitude 44° 39′ N., longitude 57° 15′ W. "I saw a jæger or gull-chaser to-day, the first I have seen since last fall."

April 29, 1879.—Latitude 44° 28′ N., longitude 57° 12′ W. "Shot three jægers and one gull to-day. There has been quite a number of jægers around for the past few days."

May 1, 1879.—Same position as above. "Shot two whiptails and three marlingspikes this morning. I shot two jægers in the afternoon; saw several Buffon's jægers but did not get any."

May 29, 1879.—South of Sable Island, latitude 43° 36′ N., longitude 59° 47′ W. "I shot a hag at noon, and another later in the day; also, a whiptail, marlingspike, and mackerel gull–[tern.]"

June 2, 1879.—Latitude 44° 36′, longitude 57° 12′ W. "Shot and skinned an Arctic jæger to-day."

July 29, 1879.—Latitude 44° 14′ N., longitude 58° 03′ W. "I have seen no noddies this trip, and jægers only twice.†

The time when jægers are most numerous on the fishing-banks, as may be seen by the foregoing notes, is in the spring, late summer, and fall. They never approach the numbers of the hagdon; sometimes, perhaps, a hundred or more may be seen flying around a vessel when fish offal is being thrown out, but twenty-five or fifty birds of this genus are about as many as are generally seen at one time.

Whenever they are near they quickly detect the presence of food by any accumulation of other birds, such as petrels or gulls. The gathering of a flock of petrels, or the first scream of a kittiwake, struggling for the possession of a piece of offal thrown over from a vessel, or pouncing on a codfish liver cast out from a boat, brings the fierce jæger to the spot, sweeping down with tremendous speed and indescribable rapacity to rob the feebler birds of what they have obtained, and so violent and persistent are its attacks that it frequently compels the gulls to disgorge the contents of their stomachs in order that they may escape the persecutions of this pirate of the air. So fearful are the kitti-

* The position was the same for October 3d and 4th as that given for the 1st.

† We sailed from Gloucester, Mass, June 19.

wakes of the jæger that invariably, so far as my observation extends, a flock of gulls that are sitting on the water will start up on a wing the instant that they are approached by either of the larger species.

It may be said, however, that the jæger rarely attacks the larger species of gulls, though I have seen the common gull—*L. zonorynchus*—fiercely chased by a jæger when the gull was flying away with food in its beak. However predaceous the marlingspike may be, so far as the gull is concerned, it never presumes to intimidate the hagdon; and there is little doubt but that the latter would become the aggressor if it found the former in possession of any desirable tid-bit.

Though the flight of the jæger is rather deliberate, almost heavy, under ordinary circumstances, it is, nevertheless, exceedingly swift when occasion calls for a display of its powers. As has been intimated it is very pugnacious, and its rapacity knows no bounds, but it is far less daring than the hagdon, neither is it so noisy as the latter.

Jægers have been used to a greater or less extent for bait by the "shack fishermen," generally being caught in the same manner as the hagdons are, with which they are usually taken, but, of course, in more limited numbers, as a rule. Sometimes they will bite quite freely at a hook covered with liver, and on several occasions I have seen a considerable number, perhaps twenty or more, caught from a vessel's side or from a boat. As a rule, however, they are too wary to be taken in any considerable numbers in this way, since they prefer to rob other and more daring birds, especially the gulls. During the summer months, when hagdons are almost the only birds (of course, always excepting Carey chickens) on the bank they have less chance to commit their depredations; therefore they are generally compelled to take the same risk that *puffinus* does or else go hungry. It is at this season that they are most frequently caught. In biting at a hook, unless the immediate presence of other birds influences its actions, the jæger generally exhibits considerable acuteness and dexterity in stripping the liver from the hook, and in this respect it is second only to the hagdon. It will take the liver in its beak and, rising in the air, will try to fly away to a distance with it before attempting to swallow it. If it is pulled away by a dexterous jerk on the line it will return and try it over again, but it is now doubly cautious, and the chances are it will get what it seeks and escape capture. But when birds are plenty and all are ravenous for food the marlingspike, in its struggles to be first, forgets its caution, and consequently becomes a victim to its greed. When hooked it almost always rises and tries to escape by flying; it rarely, if ever, splashes along like the hagdon with its feet stuck out, striking against the water in a desperate effort to hold back. It is killed, when caught on a hook, in the same way as the hagdon, but, unlike the latter, it generally stays killed, though it is by no means lacking in tenacity of life. When particularly difficult to catch on a hook it is often shot for bait. As a general thing one or two discharges of a musket causes these birds to be

shy about approaching a boat or vessel for some time afterward, and it may be anywhere from a half hour to more than an hour before one can again be enticed within gunshot. This being the case it will readily be understood that only a limited number can be obtained in this way, and it may as well be said that whenever they are shot the sport and excitement incident to the shooting is as much of an inducement for killing them as the procurement of the bodies for bait, though on some occasions I have myself found the supply of bait so obtained of considerable importance.

I have never, to my recollection, known of fishermen eating marlingspikes, but I know of no reason why they should not be as palatable as gulls or hagdons, which are frequently cooked and eaten.

GULLS (*Laridæ*).

The larger species of gulls, such, for instance, as the great black-backed gull (*Larus marinus*); the herring gull (*L. argentatus*); the burgomaster, (*L. glaucus*), Sabine's gull or the forked-tail gull (*L. Sabini*), and some other varieties which frequent the fishing-banks in greater or less abundance—the ring bill (*L. zonorynchus*) being the most numerous—have rarely been used to any extent for bait. The extreme shyness of the larger species; the fact that they, like the kittiwake, are absent from the fishing-grounds in summer (going and returning about the same time as the latter), and their comparative scarcity, even during the colder portion of the year, renders it difficult to effect their capture except by shooting them, and as one discharge of a gun will generally frighten them so badly that they will not come near again for several hours, if for the day, it seldom happens that more than one or two individuals can be got in this way, an insignificant number when several thousand hooks have to be baited. I have never seen a burgomaster or *L. marinus* caught on a hook. On several occasions I have seen the ring-bill captured in this way, but rarely more than one or two at a time. However hungry these large birds are (and they are generally very poor in flesh and in a half-famished condition), their extreme timidity generally prevents them from approaching even within gunshot of a vessel. But they will chase a kittiwake which is flying away with food with all the fierceness and persistence of a jæger, and their greater size and swiftness enables them to rob the smaller bird, though when there are several of the large gulls in pursuit of the same object—as is often the case—the result is generally a lively scrimmage in the air, which is a decidedly interesting scene to witness.

The larger gulls subsist chiefly on the small fish which they can pick up at the surface of the sea, but as they do not dive (so far, at least, as I have been able to observe) their ability to obtain food is more limited than that of the hagdon. I have rarely found any food in the stomachs of the large gulls that I have shot or caught on a hook, except, perhaps,

it might be the case that they had just swallowed some offal that had been thrown out from the vessel.

It sometimes happens that the common gull (*L. zonorynchus*) gathers in considerable numbers alongside of a vessel when fish are being dressed, and they are very active in securing their share of the offal thrown out, but, as previously stated, they depend more on watching and robbing the kittiwake than on venturing near enough the vessel to snatch the coveted morsels as they fall in the water. When they do attempt the latter feat it is interesting to note how skillfully it is performed. Its timidity prevents the ring bill from lighting to seize the food near the vessel; therefore, the instant his keen eye detects a piece of fish offal falling to the water, down he comes, swooping by with the speed of the wind, and so accurate is his flight that he rarely fails to snatch from the surface the object that he aimed at, and which he carries off in his beak to a safer distance where he can swallow it unmolested by the fear of man.

The large gulls are sometimes, though not often, eaten by the fishermen; the smaller, tenderer, and more easily caught kittiwakes are preferred. It may be of interest to mention in this connection that the coast fishermen of Newfoundland capture the young of the sea-gulls (generally of the larger species) while they are yet nestlings, and carefully rear them until they are full grown, feeding them chiefly on fish. A single family may have a dozen or twenty of these young birds. I have frequently seen ten or a dozen young gulls in a single pen at Belloram, Fortune Bay, and there were a number of such pens in the little village. In many places on the Newfoundland coast these birds, I have been told, occupy the same place that with us is filled by the domestic fowls. Instead of the conventional turkey for the holidays the coast fisherman is satisfied with the young and fat gulls which he has reared. And the family is considered fortunate which has among its members one or two enterprising boys who succeed in capturing several broods of young gulls on "off days," when they are not engaged in fishing.

THE BURGOMASTER GULL. (*Larus glaucus*).

This large and beautiful species occurs on the Grand Banks in the winter season, especially when the weather is unusually severe, or when there is an abundance of drift-ice on or near the banks. In the winter of 1879 I noticed them on several occasions while anchored on the northwest part of the Grand Banks, and on Green Bank, but, so far as my experience extends, they are never abundant. Two or three times we saw as many as ten or a dozen of them flying about the vessel, but they were so extremely shy that it was exceedingly difficult to entice them within gunshot. In my journal, under date of March 14, 1879, I made the following entry: "Almost every day since we have been here I have seen some of the burgomaster gulls." On the same cruise I succeeded in getting a specimen, the shot breaking one of its wings. I brought this bird

home in good condition on ice, and gave it to Mr. Raymond L. Newcomb, of Salem, Mass. The weather at the time I saw this species on the Grand Banks was unusually cold. So far as I had an opportunity of observing, these birds fly in pairs, and thus mated they will apparently keep together with much constancy, but they evidently have no disposition to go in flocks. Under date of March 13, 1879, is the following note in my journal: "I saw two beautiful great burgomaster gulls this forenoon; they were flying side by side to windward." Again, on March 15, I saw some splendid opportunities to shoot several burgomaster gulls, which came unusually near the vessel, but the weather was too rough to get them even if I succeeded in killing them, therefore I did not try. Its flight resembles that of the herring gull (*Larus argentatus*), though it is perhaps less swift than the latter.

Owing to the fact that the burgomaster is rarely or never seen in summer on the Grand Banks, and is so extremely timid about approaching man, it is not used for bait, since, for the reasons mentioned, it cannot be captured.

THE KITTIWAKE GULL (*Larus tridactylus*).

Of all the birds which visit the fishing-banks the kittiwake gull ("winter gull," "pinyole," etc., of the fishermen) is beyond question the most abundant, with the exception, perhaps, of the petrels or Mother Carey chickens. These gulls have a very wide distribution along the Atlanitc coast. I have seen them along the coast of New Jersey, and thence to the eastern coast of Newfoundland, and while at sea, in winter, I have met with them all the way from Cape Cod to the Grand Banks. The species occurs in great abundance on all the outer fishing-banks in winter, and at the same time is also numerous about the harbors along the coast. It is apparently gregarious, but, though it is usually met with in large flocks, as has just been stated, yet sometimes one, two, or three of these birds may follow a vessel, which is making a passage in the deep water between the fishing-banks, for several days, eagerly watching for any offal that may be thrown overboard.

Though less daring and pugnacious than the hagdon, it is perhaps even more noisy when food is obtainable. It is a constant companion of fishing-schooners when anchored on the banks, and, especially when fish are being dressed, it comes in countless numbers around the vessel ready to pounce upon the offal. At such times all of them join in a general shout whenever any of their companions succeed in getting a morsel of food, and their screams are almost deafening. Should one of them get hold of a piece of codfish liver which it cannot swallow, it immediately attempts to fly away with it, but it is pursued by hundreds of its screaming companions, who make every endeavor to steal the half-swallowed piece of food. This attempt frequently proves successful; but it does not follow that the thief profits by its enterprise, for it, in turn, is subject to the same annoyance, and perhaps may lose the food

which it has so dexterously stolen. On the other hand, three or four birds may succeed in getting hold of the liver which is half swallowed by the first; but they usually content themselves with having merely obtained a taste of the precious tidbit which may be finally torn into pieces and swallowed by a half dozen of their more fortunate companions. The voracity with which the gluttonous kittiwake swallows the bait usually insures its capture with hook and line.

This species does not, however, leave its breeding-ground along the coast nor appear upon the fishing-banks until late in autumn, and therefore the "shack-fishermen" cannot depend upon it for bait, as they do on the hagdon, for, by this time, they have generally nearly completed their fares, and in some cases have returned to their home port.

Some years ago, when the codfishermen used to remain on the Grand Banks later in the season than they do now, sometimes staying as late as November, or possibly longer, large quantities of kittiwake gulls were used for bait.

Some of the fishermen relish the bird, which, when properly cooked, makes a not unsavory dish at sea. Such a dish cannot, of course, be compared to spring chicken; but a "pot-pie" made of kittiwake gulls would probably not be regarded with indifference even by the most fastidious, and as served in some instances which have passed under my own observation, it was a very good substitute for the conventional turkey for a Thanksgiving or Christmas dinner.*

The food of the kittiwake gull usually consists of small fish and crustacea, which it is able to obtain near the surface of the water; but on the fishing-banks many of these birds procure a considerable portion, perhaps, of their food from the offal thrown overboard by the crews of the fishing vessels. Its subsistence, however, at this season is exceedingly precarious, and it is generally found with little food in its stomach and very poor in flesh. Although the kittiwake approaches a vessel or boat with considerable boldness, coming as it often does within a few feet of the side of either and recklessly darting almost within arms' length of a man engaged in throwing out a trawl, it nevertheless exhibits a remarkable timidity when a gun is fired. The most noisy and greedy gulls which have been screaming around the vessel are rendered cautious and comparatively quiet by one or two discharges of a musket, and for some time it is difficult to entice them back. However, when one or two, bolder than the rest, have succeeded in possessing themselves of some coveted morsel, the rest take courage, and in a few min-

* Capt. Henry O. Smith is authority for stating that kittiwake gulls, and occasionally some of the larger species, are caught for food by the Newfoundland fishermen in winter, a common rat trap being used to effect the capture. The trap is firmly secured to a piece of board, baited with a fish liver, and allowed to float down astern of the anchored boat on which the crew is engaged in fishing for cod or other species. The greedy gull sees the tempting morsel, makes a dash to secure it, and snap go the jaws of the trap, nipping the unfortunate bird in its grasp. This is repeated over and over again.

utes they have apparently recovered from their fright; but another discharge instantly demoralizes them again. During the violent gales which are so frequent on the fishing-banks in the winter the little gulls, though fully able to breast the force of the fiercest gale, prefer to sit upon the water unless there is a prospect of obtaining food. At such times they can almost always be seen in flocks near the stern of an anchored vessel, gracefully following the undulating upheaval of the agitated waves; one or more perhaps may be on the wing watching for the appearance of the offal which may be washed from the vessel's deck. The least indication of food instantly brings them all on the wing, and, with their usual noisy scrambles in robbing one another, they go skurrying off before the wind, rising and falling over the crests of the breaking waves. It not only behooves the gulls at such times to keep a sharp lookout for food, but they must be equally watchful for their safety; for, should they be caught beneath the crest of one of the huge, curling and topling waves, they would be instantly crushed or torn to pieces. They are, therefore, constantly on the alert in a gale, and are ready to rise on the wing and to fly over the crest of a breaking wave and immediately alight on the opposite side.*

In the spring the kittiwake leaves the bank and goes inshore to its breeding-grounds. Its nests are easily found upon the Newfoundland shores, and very likely at many other places along the coast.†

TERNS.

The common tern (*Sterna hirundo*) Linn., occurs during summer in limited numbers on the banks east of Sable Island. This species was taken by Newcomb when with me on Banquereau. The common mackerel gull of the fishermen, the Arctic tern (*S. arctica*) is very abundant in summer on the fishing banks near Sable Island, where it is said to breed in great numbers. On September 3, 1878, Newcomb shot one of these birds some 25 miles eastward of Sable Island.‡

Like the kittiwake, the terns are exceedingly noisy, and often gather in great numbers about a vessel from which fish-offal is being thrown, but they are rarely abundant on the banks except in the immediate vicinity of Sable Island; they are somewhat difficult to catch on a hook, and also because of the smallness of their bodies, they are seldom if ever used for bait.

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* The following note I find in my journal under date of February 11, during the prevalence of a heavy gale on the Grand Banks which I was riding out at anchor: "The little white gulls sit hovering on the water near the stern of the vessel, occasionally rising on a wing to clear a breaking wave, or to pick up any fish-offal that may be washed from the scuppers."

† In my journal, under date of April 29, 1879, I find the following note relative to the departure of the winter gulls from the outer banks: "The little white gulls are growing scarce, they leave for land about this time."

‡ The specimen alluded to was called an Arctic tern by Mr. Newcomb, who is my authority in this matter.

PETRELS OR MOTHER CAREY'S CHICKENS (genera *Cymochorea* and *Oceanites.*)

There are several varieties of the petrels commonly found in great abundance on the fishing-banks from spring to fall. They usually make their first appearance in April, the date varying somewhat with different seasons—some springs, perhaps, being slightly warmer than others—and remain until after the first snow-storms in the fall. Under date of April 19, 1879, when on the eastern part of Banquereau, I noted that "Petrels made their first appearance to-day. These birds generally leave the bank late in October or early in November and come again in April or May."

Just how many species of petrels occur on the fishing-banks I am unable to say, but I believe there are at least three, and possibly more. Of these, I think Leach's petrel (*C. leucorrhoa*) is the most abundant on the Grand Banks, while the Wilson petrel (*O. oceanicus*) is also numerous.

These birds are excessively fond of oily food, and may always be seen in great numbers around a vessel or boat from which particles of fish liver or other offal are being thrown out. In describing the hagdon, mention has been made of certain peculiarities which the Carey chickens exhibit in the matter of seeking and eating their food; such, for instance, as their supposed ability to follow up a scent, and the way they work together in a united effort to tear into fragments a section of liver which is so large that one bird cannot manage it. A favorite method of feeding which the petrels exhibit is to dance upon the water's surface, picking up any oily particles that may be floating thereon, and which, though small in themselves, in the aggregate afford the birds much food. To them these bits are particularly attractive. As it frequently happens that fish oil, or other fatty particles are being thrown out or washed from the deck of a fishing-vessel, one who may be on board has a very good opportunity of noting these habits of the petrels. When caught, it almost invariably ejects an oily, strong-smelling substance, and the contents of its stomach are thrown out, as a rule, the instant it is taken into a boat or on a vessel's deck. In a very few minutes after being caught its appearance changes wonderfully; and, instead of its feathers looking clean and sleek, they become, almost immediately, damp and dirty, and have a decidedly bedraggled look. If, after being on a vessel's deck for ten minutes or thereabouts, it is thrown overboard, the probabilities are that the petrel cannot fly at all, and it is only with the utmost difficulty that it can rise a few feet from the water, into which it soon falls again. If the bird's strength is sufficient to sustain it in a continuous effort to dry its wings and feathers, it at last succeeds in supporting itself in the air. As soon, however, as it dares, it lights on the water and proceeds to arrange its plumage.

The natural position of the Carey chicken may be said to be that of

constant motion and activity on the wing. It seems to be as nearly tireless as it is possible for any living animal to be. So rarely, indeed, are they seen sitting at rest on the water, that sailors have acquired certain superstitions connected therewith, though these beliefs are not always the same. For instance, I have heard it said by some that to see Carey chickens sitting on the water was a sign of a long spell of calm weather, while others as firmly believed such an occurrence was a sure precursor of a storm.

Whether petrels rest at night or not I am unable to say positively, though there are strong reasons for believing they do not. On hundreds of occasions I have seen them flying about the vessel on moonlight nights, and nothing is more common than for a man on lookout on a dark foggy night to be startled by the chirp of a Carey chicken, which, attracted by the brilliancy of the riding light, suddenly finds himself over the vessel's deck, and in too close proximity to quarters he prefers to avoid.

Petrels have been used to some extent for bait, but because of the small size of their bodies, a single bird being scarcely large enough to bait two hooks, they have never been considered an important source of bait supply. The fact that they are almost entirely indifferent to the presence of man, and that they will gather in great numbers within a few feet of the side of a boat or vessel, renders it an easy matter to kill them. This being the case some of the "shack fishermen," when other sources of bait supply failed to afford the requisite quantity, often killed hundreds of petrels in a single day to make up the deficiency, though it is possible the slaughter of these birds was less than it would have been, because of the superstition common among seafaring men, that it is "unlucky" to kill Mother Carey's chickens.

The most common and effective way of killing them was with a whip, which was made by tying several parts of codline—each part 6 to 8 feet long—to a staff 5 or 6 feet in length. The petrels were tolled up by throwing out a large piece of codfish liver, and when they had gathered in a dense mass, huddling over the object which attracted them, swish went the thongs of the whip cutting their way through the crowded flock, and perhaps killing or maiming a score or more at a single sweep. By the time these were picked up another flock was gathered, and the cruel work went on until, may be, 400 or 500 birds were killed, though, perhaps, it was seldom that so great a number was obtained at once.

GUILLEMOTS.

THE FOOLISH GUILLEMOT OR MURRE (*Uria troile*) Linn.*

In spring large flocks of murres are seen on the fishing-banks, migrating northwardly. I have noticed them in greatest abundance on Ban-

*Although the Guillemots do not come under the head of birds used for bait, I have nevertheless deemed it best to note their appearance on the banks.

quereau, east of Sable Island. The flocks reach this locality in April, and from the 20th of that month to the middle of May are more numerous, as a rule, than at any other time. April 26, 1879, latitude 44° 32′ N., longitude 57° 12′ W., I "saw several flocks of murres," and three days later there were "large numbers of murres."

A single individual is sometimes seen in summer on the banks, but this is by no means a common occurrence. In the fall, however, they are more numerous, as at this season they are performing their autumnal migration southwardly, but, whatever the reason may be, they do not, I believe, appear on the banks in such abundance at this season as during the spring months. They are sometimes killed and eaten by the fishermen, but are never obtained in any considerable numbers. On a few occasions I have shot one or two individuals, and they are some times knocked over with an oar by the men engaged in hauling a trawl, when the murres have approached closely enough to the boat to make such a feat possible. I have noted in my journal under date of October 1, 1878, latitude 43° 54′ N., longitude 58° 32′ W., that "one of the crew killed a murre while hauling his trawl, and I skinned it."

Little guillemot or sea dove (*Mergulus alle*) Linn.

The little guillemot, commonly called "Ice bird" by the fishermen, is frequently seen on the banks in winter, more particularly in the vicinity of field ice, but I have never observed it in any considerable numbers. It is fond of staying close to a fishing-vessel at anchor, it being attracted by the offal that is thrown over, and which, when sinking, is secured and eaten by the little guillemot, which is an expert diver. I have often watched one of these birds dive beneath a schooner and taking in its beak a morsel of sinking food, rise on the opposite side of the vessel from that where it went down. It is seemingly almost unconscious that it is encountering danger when approaching a vessel or boat. I have seen it swimming within 2 feet of a schooner's side without making an effort to go farther off unless some one attempted to kill it.

INDEX.

NOTE.—The references are to page-figures in brackets.

XIV.—LIST OF FISHES COLLECTED BY THE U. S. FISH COMMISSION AT WOOD'S HOLL, MASSACHUSETTS, DURING THE SUMMER OF 1881.

By Tarleton H. Bean.

Orthagoriscidæ.

Mola rotunda Cuv. Sunfish.

Tetrodontidæ.

Tetrodon turgidus Mitch. Swellfish.

Balistidæ.

Monacanthus hispidus (L.) J. & G. File-fish.
Monacanthus sp. File-fish.

Syngnathidæ.

Siphostoma fuscum (Storer) Jor. & Gilb. Pipe-fish.

Maltheidæ.

Halieutæa senticosa Goode. Spiny bat-fish.

Lophiidæ.

Lophius piscatorius L. Goose-fish.

Gasterosteidæ.

Apeltes quadracus (Mitch.) Brevoort. Four-spined stickleback.
Gasterosteus aculeatus L. Two-spined stickleback.
Gasterosteus pungitius L. Many-spined stickleback.

Soleidæ.

Achirus lineatus (L.) Cuv. American sole.
Aphoristia plagiusa (L.) J. & G.

Pleuronectidæ.

Citharichthys arctifrons, Goode.
Glyptocephalus cynoglossus (L.) Gill. Pole flounder.
Hippoglossoides platessoides (Fabr.) Gill. Sand dab.

Limanda ferruginea (Storer) G. & B. Rusty flounder.
Bothus maculatus (Mitch.) J. & G. Spotted sand flounder.
Monolene sessilicauda Goode.
Paralichthys dentatus (L.) G. & B. Common flounder.
Paralichthys oblongus (Mitch.) J. & G. Four-spotted flounder.
Pleuronectus americanus (L.) Walb. Flat fish.

MACRURIDÆ.

Coryphænoides rupestris Gunner.
Macrurus bairdii G. & B. Baird's grenadier.
Macrurus carminatus Goode.

OPHIDIIDÆ.

Leptophidium profundorum Gill.

BROTULIDÆ.

Brotulid (genus undetermined).

GADIDÆ.

Gadus morrhua L. Cod.
Gadus tomcodus Walb. Tom-cod.
Melanogrammus æglefinus (L.) Gill. Haddock.
Phycis chuss (Walb.) Gill. Hake.
Phycis tenuis (Mitch.) DeKay. Common hake.
Phycis chesteri Goode & Bean. Chester's hake.
Physiculus dalwigkii Kaup.
Physiculus (new species).
Læmonema barbatula Goode & Bean.
Haloporphyrus viola Goode & Bean. Blue hake.
Onos cimbrius (L.) Goode & Bean. Rockling.
Merlucius bilinearis (Mitch.) Gill. Whiting.

LYCODIDÆ.

Lycodes paxillus G. & B.
Lycodes vahlii Reinhardt. Vahl's lycodes.
Lycodes verrillii G. & B. Verrill's lycodes.
Lycodes (undetermined species).
Lycodes (undetermined species).
Melanostigma gelatinosum Günther.
Zoarces anguillaris (Peck.) Storer. Mutton-fish; eel pout.

AMMODYTIDÆ.

Ammodytes americanus DeKay. Sand launce.

STICHÆIDÆ.

Eumesogrammus subbifurcatus (Storer) Gill.

XIPHISTERIDÆ.

Murœnoides gunellus (L.) G. & B. Rock-eel.

BATRACHIDÆ.

Batrachus tau (L.) C. and V. Toad-fish.

LIPARIDIDÆ.

Monomitra liparina Goode.
Careproctus reinhardtii Kröyer.
Liparis (In *Pecten tenuicostatus.*)
Liparis lineatus (Lepechin) Kröyer.

CYCLOPTERIDÆ.

Cyclopterus lumpus L. Lump fish.

GOBIIDÆ.

Gobiosoma bosci (LaC.) J. & G.
Hemitripterus americanus (Gmel.) C. & V. Sea raven.

TRIGLIDÆ.

Peristedium miniatum Goode.
Prionotus palmipes (Mitch.) Storer. Sea robin.
Prionotos evolans (L.) Gill. Striped sea robin.

AGONIDÆ.

Aspidophoroides monopterygius (Bloch) Storer.

COTTIDÆ.

Cottunculus microps Collett.
Cottunculus torvus Goode.
Cottus œneus Mitch. Pigmy sculpin.
Cottus octodecimspinosus Mitch. Sculpin.
Triglops pingelii Reinh. Mailed sculpin.

SCORPÆNIDÆ.

Sebastes marinus (L.) Lütken. Red-fish.
Setarches parmatus Goode.
Sebastoplus dactylopterus (De la Roche) Gill. Rose-fish.

LABRIDÆ.

Tautoga onitis (L.) Günther. Tautog.
Ctenolabrus adspersus (Walb.) Goode. Cunner.

TRICHIURIDÆ.

Benthodesmus elongatus (Clarke) G. & B.

SCOMBRIDÆ.

Orcynus thynnus (L.) Goode. Horse mackerel.

CARANGIDÆ.

Caranx chrysus (Mitch.) Gthr. Crevallé.

STROMATEIDÆ.

Lirus perciformis (Mitch.) J. & G. Rudder-fish.
Stromateus triacanthus Peck. Butter-fish.

LATILIDÆ.

Lopholatilus chamæleonticeps Goode & Bean. Tile-fish.

BERYCIDÆ.

Hoplostethus mediterraneus C. & V.

SPARIDÆ.

Stenotomus chrysops (L.) Bean. Scup.

SERRANIDÆ.

Centropristis nigricans C. & V. Sea bass.

POMATOMIDÆ.

Pomatomus saltatrix (L.) Gill. Blue fish.

ECHENEIDIDÆ.

Echeneis naucrates L. Sucker; Pegador.
Echeneis brachyptera Lowe. Sword-fish; sucker.

ATHERINIDÆ.

Menidia notata (Mitch.) J. & G. Silverside.

CENTRISCIDÆ.

Centriscus scolopax L. Snipe-fish.

BELONIDÆ.

Tylosurus caribbæus (Le S.) J. & G. Gar-fish.
Tylosurus marinus (Bl. Schn.) J. & G. Silver gar.

STERNOPTYCHIDÆ.

Argyropelecus hemigymnus.
Cyclothone lusca. Goode & Bean.
Gonostoma denudata (Raf.) Bonap.
Chauliodus sloanii Schn.

STOMIATIDÆ.

Stomias ferox Reinhardt.

SCOPELIDÆ.

Scopelus, 2 or more species.
Maurolicus borealis (Nilss.) Gthr.

MICROSTOMIDÆ.

Chlorophthalmus agassizii Bonap.
= *Hyphalonedrus chalybeius* Goode.

ANGUILLIDÆ.

Conger niger (Risso) J. & G. Conger eel.
Ophichthys undetermined species.

NEMICHTHYIDÆ.

Nemichthys scolopaceus Rich. Snipe eel.

SYNAPHOBRANCHIDÆ.

Synaphobranchus pinnatus (Gronow) Günther. Twin-gilled eel.

SIMENCHELYIDÆ.

Simenchelys parasiticus Gill. Pug-nose eel.

MYLIOBATIDÆ.

Rhinoptera quadriloba (Le S.) Cuv. Cow-nosed ray.

TRYGONIDÆ.

Trygon centrura (Mitch.) Linsley. Sting ray.

RAIIDÆ.

Raia eglanteria LaC. Skate.
Raia erinacea Mitch. Clear-nosed skate.
Raia lævis Mitch. Barn-door skate.
Raia ocellata Mitch. Spotted skate.
Raia radiata Donovan. Prickly skate.

GALEORHINIDÆ.

Carcharias obscurus (Le S.) Jor. & Gilb. Dusky shark.
Mustelus canis (Mitch.) DeKay. Smooth dog-fish.

SCYLLIIDÆ.

Scylliorhinus retifer (Garman) Jor. & Gilb. Marbled dog-fish.

SPINACIDÆ.

Centroscyllium fabricii (Reinh.) Müll. & Henle. Greenland dog-fish.
Squalus acanthias L. Spined dog-fish.

PETROMYZONTIDÆ.

Petromyzon marinus L. Lamprey eel.

MYXINIDÆ.

Myxine glutinosa L. Hag; Slime-fish.

XV.—REPORT ON THE DECAPOD CRUSTACEA OF THE ALBATROSS DREDGINGS OFF THE EAST COAST OF THE UNITED STATES IN 1883.

By Sidney I. Smith.

With the exception of three or four species represented by specimens too imperfect for proper determination or description, this report includes all the true Decapoda from the dredgings of the Albatross in 1883. In the lists of specimens examined I have endeavored to enumerate every specimen which has been submitted to me in order to indicate as far as possible the relative abundance of the species at the different stations. In these lists I have given the temperature and nature of the bottom as fully as the data accessible to me permitted. In indicating the nature of the bottom the following abbreviations, after the Coast Survey system, are used:

Materials.	Colors.	Other qualities.
C. for clay.	bk. for black.	brk. for broken.
Cr. for corals.	bn. for brown.	crs. for coarse.
F. for foraminifira.	bu. for blue.	fne. for fine.
G. for gravel.	dk. for dark.	glb. for globigerina.
M. for mud.	gn. for green.	hrd. for hard.
O. for ooze.	gy. for gray.	rky. for rocky
P. for pebbles.	lt. for light.	sft. for soft.
R. for rocks.	rd. for red.	sml. for small.
S. for sand.	wh. for white.	
Sh. for shells.		
Spg. for sponges.		
St. for stones.		

In the column for the number of specimens examined, *l* is used to indicate large specimens; *s*, small specimens; and *y*, young. When the sexes were not counted separately the whole number of specimens examined is placed in the middle of the column; when the sexes were counted separately the number of males is put on the right, the number of females on the left, and the number of young in the middle, followed by the letter *y*. As a basis for ascertaining the breeding season, I have, in a great number of cases, noted the presence or absence of egg-bearing females; when the number of such females was counted it is entered in the appropriate column; when specimens carrying eggs were found, but not counted, a plus sign, +, is used; and when none of the specimens examined were carrying eggs a zero, 0, is used. The National Museum catalogue numbers are given for all the specimens except those which I examined at Wood's Holl before they were catalogued. When

the record of specimens examined is not given in tabular form these catalogue numbers simply follow in parenthesis the mention of the specimens. In a few cases I have added to the list of specimens taken by the Albatross (Stations 2001 to 2116) those taken off Martha's Vineyard in 1883 by the Fish Hawk (Stations 1156 to 1176).

BRACHYURA.

MAIOIDEA.

AMATHIA AGASSIZII Smith.

Bull. Mus. Comp. Zool., x, p. 1, pl. 2, figs. 2, 3, 1882; Proc. National Museum, vi, p. 3, 1883.

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens— ♂	Specimens— ♀	Specimens— With eggs.
		° ′ ″	° ′ ″	*Fath.*					
5379	2092	39 58 35	71 00 30	197	45°; gn. M.	Sept. 21	1		......
5693	2109	35 14 20	74 59 10	142	50½°; bu. M.	Nov. 9	1*l.*	1*l.*	0

The two specimens from Station 2109 are much larger than any previously obtained, and are fully adult. These specimens differ from the smaller ones described and figured, principally in having proportionally much shorter rostral horns, shorter spines upon the carapax, and longer peræopods. The female, as usual, has much shorter chelipeds and a broader and more swollen carapax than the males. These differences are all well shown by comparing the accompanying measurements with those previously given.

Measurements in millimeters.

Catalogue number	5693	5693
Station	2109	2169
Sex	♂	♀
Length of carapax, including rostral and posterior spines	58.0	71.3
Length of carapax from base of rostral to tip of posterior spines	51.5	62.2
Length of carapax, excluding rostral and posterior spines	51.0	62.2
Length of rostral horns or spines	7.5	10.0
Breadth of carapax, including lateral spines	44.3	54.0
Breadth of carapax, excluding lateral spines	41.3	51.0
Length of branchial spines	3.5	4.0
Length of cheliped	95.0	94.0
Length of chela	44.0	44.0
Breadth of chela	6.0	6.2
Length of dactylus	14.5	17.0
Length of first ambulatory peræopod	146.0	183.0
Length of dactylus	25.0	28.5
Length of second ambulatory peræopod	122.0	146.0
Length of dactylus	21.6	25.0

In the two large specimens (5693), after preservation in alcohol for several weeks, the distal parts of the meri and portions of the carpi of all

the peræopods, and the distal ends of the propodi of the ambulatory ones, are conspicuously marked with dark red, the color being more extensive on the first and second ambulatory peræopods.

Hyas coarctatus Leach.

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens— ♂	Specimens— ♀	Specimens— With eggs.
		° ′ ″	° ′ ″	*Fath.*					
5571	2012	36 41 15	74 39 50	66	....	Apr. 30		2y.	0
5599	2012	36 41 15	74 39 50	66	....	Apr. 30	1		......
5589	2014	36 41 05	74 38 53	373	S. brk. Sh.	May 1		1*s*.	0
....	2057	42 01 00	68 00 30	86	brk. Sh.	Aug. 30	2	7	5
....	2058	41 57 30	67 58 00	35	50°; gy. S.	Aug. 30	1	3	2
....	2059	42 05 00	66 46 15	41	bu. M. S.	Aug. 31	1	1	0
....	2062	42 17 00	66 37 15	150	42°; S. G.	Aug. 31		1	0
....	2065	42 27 00	65 00 45	80	44½°; S.G.bk.Sh.	Aug. 31		1	1
7077	2066	42 19 40	65 49 30	65	43¼°; St. G.	Sept. 1	1	3	3
....	2076	41 13 00	66 00 50	906	bu. M.	Sept. 4	1		......
....	2081	41 10 20	66 30 20	46	50°; wh. S.	Sept. 4	2		......
....	2081	(from stomach of cod)		......	....	....	5	3	3
....	2082	41 09 50	66 31 50	49	46½°; crs. S. G.	Sept. 4	9	5	2
....	1157	40 14 00	70 29 15	62	45°; sft. M.	Aug. 23	2		......
....	1159	40 20 00	70 35 00	41	44°; sft. M.	Aug. 23	1*s*.		......

Collodes robustus Smith.

Proc. National Mus., vi, p. 5, 1883.

(Plate I, Figs. 1, 1*a*, 2, 2*a*, 2*b*.)

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens— ♂	Specimens— ♀	Specimens— With eggs.
		° ′ ″	° ′ ″	*Fath.*					
5518	2004	37 19 45	74 26 00	98	gn. M. Sh.	Mar. 23	3	1	1
5528	2004	37 19 45	74 26 00	98	gn. M. Sh.	Mar. 23		1	1
5532	2005	37 18 11	74 27 36	78	bu. M. S. Sh.	Mar. 23	10	3	3
5600	2014	36 41 05	74 38 53	373	S. brk. S.	May 1	1		

Euprognatha rastellifera Stimpson.

(Plate I, Figs. 3, 3*a*.)

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens. ♂	Specimens. ♀	Specimens. With eggs.
		° ′ ″	° ′ ″	*Fath.*					
5527	2004	37 19 45	74 26 00	98	gn. M. Sh.	Mar. 23	13	2	2
5537	2004	37 19 45	74 26 00	98	gn. M. Sh.	Mar. 23	12	2	2
5520	2005	37 18 11	74 27 36	78	bu. M. S. Sh.	Mar. 23	18	2	2
5542	2005	37 18 11	74 27 36	78	bu. M. S. Sh.	Mar. 23		1	1
7133	2012	36 41 15	74 39 50	66	....	Apr. 30	1		......

CANCROIDA.

CANCER IRRORATUS Say.

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens— ♂	Specimens— ♀	Specimens— With eggs.
		° ′ ″	° ′ ″	*Fath.*					
5609	2015	37 31 00	74 53 30	19	S. Sh.	May 5	1*s.*	1*s.*	0
5615	2016	37 31 00	74 52 36	19	42½°; S. Sh.	May 5	1	1	0
5595	2017	37 30 48	74 51 29	18	42½°; S. Sh.	May 5	5*s.*	3*s.*	0
5613	2017	37 30 48	74 51 29	18	42½°; S. Sh.	May 5	2		0
....	2057	42 01 00	68 00 30	86	brk. Sh.	Aug. 30	1		......
....	2058	41 57 30	67 58 00	35	50°; gy. S.	Aug. 30	1		......
7014	2085	40 05 00	70 34 45	70	50°; bu. M.	Sept. 20		1*s.*	0

CANCER BOREALIS Stimpson.

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens— ♂	Specimens— ♀	Specimens— With eggs.
		° ′ ″	° ′ ″	*Fath.*					
5519	2004	37 19 45	74 26 00	98	gn. M. Sh.	Mar. 23	6*y.*		......
5524	2005	37 18 11	74 27 36	78	bu. M. S. Sh.	Mar. 23		1	0
5577	2011	36 38 30	74 40 10	81	S. brk. Sh.	Apr. 30	1*y.*		......
5616	2011	36 38 30	74 40 10	81	S. brk. Sh.	Apr. 30	2		......
5592	2012	36 41 15	74 39 50	66	....	Apr. 39	5*s.* 12*y.*	4*s.*	0
5678	2012	36 41 15	74 39 50	66	....	Apr. 30	1		......
5614	2014	36 41 05	74 38 53	373	S. brk. Sh.	May 1	2	1	0
5602	2014	36 41 05	74 38 53	373	S. brk. Sh.	May 1		3	0
5582	2017	37 30 48	74 51 29	18	45½°; S. Sh.	May 4	1*y.*		......
5375	2085	40 05 00	70 34 45	70	50°; bu. M.	Sept. 20	1		......
5408	2086	40 05 05	70 35 00	69	52½°; bu. M. gy. S.	Sept. 20	2	2	0
5410	2087	40 06 50	70 34 15	65	50°; gn. M. S.	Sept. 20		2*c.*	0
5420	2087	40 06 50	70 34 15	65	50°; gn. M. S.	Sept. 20	1*s.*	1*s.*	0
5372	2088	39 59 15	70 36 30	143	48°; yl. S.	Sept. 20	1*y.*		......
5411	2088	39 59 15	70 36 30	143	48°; yl. S.	Sept. 20		2*l.*	0
5369	2089	39 58 50	70 39 40	168	45°; gy. S.	Sept. 20	1*s.*		......
5364	2090	39 59 40	70 41 10	140	48½°; S. brk. Sh.	Sept. 20	1	1*y.*	0
5419	2090	39 59 40	70 41 10	140	48½°; S. brk. Sh.	Sept. 20	1*y.*		......
5409	2091	40 01 50	70 59 00	117	49°; gn. M.	Sept. 20	1*l.*		......
5691	2109	35 14 20	74 59 10	142	50½°; bu. M.	Nov. 9	10	6	0
....	1158	40 16 00	70 31 00	62	45°; sft. gn. M.	Aug. 23	1*y.*	1	0
....	1159	40 20 00	70 35 00	55	44°; sft. M.	Aug. 23	1*y.*	1	0
....	1160	40 24 00	70 35 00	41	43°; bk. M.	Aug. 23		1*s.*	0
....	1162	40 32 00	70 39 00	45	46½°; bk. M.	Aug. 23	1*y.*		......
....	1163	40 35 30	70 41 00	31	46°; S. M.	Aug. 23	1*y.*		......
....	1164	40 43 00	70 45 00	31	44°; M.	Aug. 23	1		......
....	1165	41 50 00	70 49 00	32	45°; gy. S.	Aug. 23		1*s.*	0

GERYON QUINQUEDENS Smith.

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens— ♂	Specimens— ♀	Specimens— With eggs.
		° ′ ″	° ′ ″	*Fath.*					
5612	2030	39 29 45	71 43 00	588	....	May 26		1	0
....	2053	42 02 00	68 27 00	105	bu. M.	Aug. 29	2*s.*		......

ACHELOUS GIBBESII Stimpson.

Neptunus Gibbesii A. M.-Edwards.

Station 2107, November 9, north lat. 35° 19′ 30″, west long. 75° 15′ 20″, 16 fathoms.—Three specimens (5633), one male and two females, one of which is carrying eggs.

LEUCOSOIDEA.

PERSEPHONE PUNCTATA Stimpson ex Browne.

Station 2114, November 10, north lat. 35° 20′, west long. 75° 20′, 14 fathoms, mud and broken shells.—One adult female (5655), and two very small young (5664).

DORIPPIDEA.

ETHUSINA, gen. nov.

This genus is nearly allied to *Ethusa*, which it resembles closely except in the form of the front and the structure of the eyes. The front, between the eyes, is quadridentate as in *Ethusa*, but the basal segments of the antennulæ are very large and swollen, occupy the whole width of the front, and crowd back the eyes and antennæ into an almost transverse position nearly beneath the outer orbital angles, which are reduced to small lateral teeth far back from the front. The eye-stalks are very small, and immovably imbedded in the orbits, which closely inclose them to near the tips, except for a narrow space beneath. The oral appendages are almost exactly as in *Ethusa microphthalma*, but there are no podobranchiæ at the bases of the first gnathopods, so that there are only six branchiæ each side, two arthrobranchiæ each at the base of the second gnathopod and first peræopod, and one pleurobranchia each for the second and third peræopods.

ETHUSINA ABYSSICOLA, sp. nov.

(Plate II, Figs. 1, 1*a*.)

Male.—The carapax at the branchial regions is nearly as broad as the length to the middle of the front, but much narrowed anteriorly, the breadth of the front being about three-eighths of the length. The middle teeth of the front are triangular, slightly upturned, and separated by a triangular sinus a little broader and deeper than the rounded antennular sinuses, while the lateral teeth are spiniform and longer than the middle teeth but more strongly upturned, so that they scarcely project in front of them. The surface of the carapax is nearly naked, granulous, and areolated very nearly like that of *Ethusa microphthalma*.

The eye-stalks project very slightly beyond the minute post-orbital teeth, taper distally, are armed with a longitudinal ridge below, and bear at the tips black eyes much smaller than the diameter of the stalks.

The chelipeds are equal, smooth, and naked, and less than twice as long as the carapax, the merus is about a third of the entire length, slender, unarmed, and without angles; the carpus is short, rounded

above, and unarmed; the chela is nearly as long as the rest of the cheliped, nearly a third as broad as long, the body somewhat swollen, rounded, smooth, and wholly unarmed, and the digits about as long as the body of the chela, nearly alike, compressed, longitudinally grooved, and the prehensile edges sharp and undulate. The first and second ambulatory peræopods are nearly alike, about twice as long as the chelipeds, slender, smooth, and nearly naked; the propodus is a little shorter than the merus, and slightly compressed, and the dactylus considerably longer than the propodus, very much compressed, regularly curved, of nearly uniform breadth to the short and acute tip, and longitudinally grooved. The third and fourth ambulatory peræopods are nearly alike, about three-eighths as long as the second pair, slender, and subcylindrical; the distal segments, except the tips of the dactyli, are slightly hairy and pubescent, and the dactyli less than half as long as the propodi, not very strongly curved, and armed with a few slender spinules on the incurved side.

The pleon is widest at the third somite which is consolidated with the fourth and fifth, and projects either side in an obtusely rounded tubercle; the sixth somite is about a half broader than long, and the seventh a little shorter than the sixth, broader than long, and rounded at the tip.

In the *female*, the carapax is broader, thicker, much more convex, both longitudinally and transversely, narrower, and armed with very much smaller teeth. The chelipeds are smaller and the chelæ much more slender, being scarcely more than a third as broad as long.

Measurements in millimeters.

Station	2037	2037	2037	2037
Sex	♂	♂	♂	♀
Length of carapax to middle of front	11.3	13.4	14.0	14.8
Length of carapax including frontal teeth	11.8	14.3	15.0	15.5
Breadth between lateral spines of front	4.2	5.4	5.1	4.2
Greatest breadth at branchial regions	10.5	13.5	13.3	14.5
Length of cheliped	19.0	24.4	24.5	22.0
Length of chela	9.0	11.3	12.0	9.6
Breadth of chela	2.7	3.9	3.8	2.5
Length of dactylus	4.4	6.0	6.3	5.5
Length of second ambulatory peræopod	41.0	52.0	53.0	48.0
Length of its propodus	9.0	12.4	12.3	10.5
Length of its dactylus	12.0	14.5	15.0	15.0
Length of fourth ambulatory peræopod	15.5	20.0	20.5	20.0
Length of its propodus	2.6	3.7	3.6	3.3
Length of its dactylus	1.1	1.4	1.7	1.6

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens— ♂	Specimens— ♀	Specimens— With eggs.
		° ′ ″	° ′ ″	*Fath.*					
7118	2036	38 52 40	69 24 40	1,735	38°; glb. O.	July 18		1*y.*	0
7119	2037	38 53 00	69 23 30	1,731	38°; glb. O.	July 18	4	1	0
5696	2106	37 41 20	73 03 20	1,497	42½°; glb. O.	Nov. 6	1*y.*	1*y.*	0

ANOMURA.

LATREILLIDEA.

LATREILLIA ELEGANS Roux.

(Plate II, Figs. 2, 2*a*; Plate III, Fig. 1.)

Station 2085, September 20, north lat. 40° 05′, west long. 70° 34′ 45″, 70 fathoms, blue mud, temperature 50°—1 ♀ (5379).

HOMOLIDEA.

HOMOLA BARBATA White ex Fabricius.

Station 2014, May 1, north lat. 36° 41′ 05″, west long. 74° 38′ 53″, 373 fathoms—2 ♂ (5593). Station 2088, September 20, north lat. 39° 59′ 15″, west long. 70° 36′ 30″, 143 fathoms, yellow sand, temperature 48°—1 fragmentary specimen (5371).

PORCELLANIDEA.

PORCELLANA SAYANA White ex Leach.

Porcellana ocellata Gibbes.

A small male (5663) apparently of this species from Station 2108, north lat. 35° 16′, west long. 75° 02′ 30″, 48 fathoms, mud and sand, temperature 66°.

LITHODIDEA.

LITHODES MAIA Leach.

Station 2063, August 31, north lat. 42° 23′, west long. 66° 23′, 141 fathoms, sand and coarse gravel, temperature 46°—1 ♀.

LITHODES AGASSIZII Smith.

Bull. Mus. Comp. Zool., x, p. 8, pl. 1, 1882; Proc. National Mus., vi, p. 25, 1883.

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens— ♂ ♀	Specimens— With eggs.
		° ′ ″	° ′ ″	*Fath.*				
7081	2077	41 09 40	66 02 00	1,255	39°; bu. M.	Sept. 4	2*y*.	0
5679	2115	35 49 30	74 34 45	843	39°; M. fne. S.	Nov. 11	3*y*.	0

PAGURIDEA.

EUPAGURUS BERNHARDUS Brandt ex Linné.

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens— No.	Specimens— With eggs.
		° ′ ″	° ′ ″	*Fath.*				
5631	2017	37 30 48	74 51 29	18	45°; S. Sh.	May 5	19*s*.	......
7137	2017	37 30 48	74 51 29	18	45°; S. Sh.	May 5	1*l*.	1
....	2057	42 01 00	68 00 30	86	brk. Sh.	Aug. 30	7*l*.	......
....	2058	41 57 30	67 58 00	35	50°; gy. S.	Aug. 30	7*l*.	......
....	2081	41 10 20	66 30 20	50	46°; wh. S.	Sept. 4	6	......
....	2082	41 09 50	66 31 50	49	46½°; crs. S. G.	Sept. 4	8	......
....	1165	40 50 00	70 49 00	32	45°; gy. S.	Aug. 23	1	......
....	1172	Off Katama Pt., M.V.		5	62°; S.	Sept. 6	3*l*.	......
....	1176	Off Katama Pt., M.V.		13	60°; S.	Sept. 6	5*l*.	......

EUPAGURUS POLITUS Smith.

Bull. Mus. Comp. Zool., x, p. 12, pl. 2, fig. 5, 1882; Proc. National Mus., vi, p. 27, pl. 4, fig. 4, 1883.

*Specimens examined.**

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens— No.	Specimens— With eggs.
		° ′ ″	° ′ ″	*Fath.*				
5522	2003	37 16 30	74 20 36	640		May 23	5	......
5523	2004	37 19 45	74 26 00	98	gn. M. Sh.	May 23	4	......
5526	2004	37 19 45	74 26 00	98	gn. M. Sh.	May 23	1	0
5535	2004	37 19 45	74 26 00	98	gn. M. Sh.	May 23	2	......
5534	2005	37 18 11	74 27 36	78	bu. M. S. brk. Sh.	May 23	5	......
5591	2011	36 38 30	74 40 10	81	S. brk. Sh.	Apr. 30	2	......
5605	2014	36 41 05	74 38 53	373	S. brk. Sh.	May 1	8	......
5610	(†)	....	....	......	S. brk. Sh.	May 1	4	......
5563	2015	37 31 00	74 53 30	‡19	....	....	1*s.*	......
5574	2020	37 37 50	74 15 30	143	S. bu. M.	May 21	1*y.* E.	......
5607	2025	40 02 05	70 27 00	239	40½°; gn. M.	May 25	8	0
5626	2025	40 02 05	70 27 00	239	40½°; gn. M.	May 25	1*y.*	0
5611	2026	40 04 00	70 28 50	131	48°; gn. M.	May 25	18*s.* (15 E.)	......
5585	2026	40 04 00	70 28 50	131	48°; gn. M.	May 25	4	......
5586	2027	39 58 25	70 37 00	197	43°; bu. M. S.	May 25	7	0
5604	2028	39 57 50	70 32 00	204	41°; bu. M.	May 25	5	0
5630	2025	40 02 05	70 27 00	239	40½°; gn. M.	May 25	1*y.*	......
....	2079	41 13 00	66 19 50	75	45°; wh. S.	Sept. 4	3	......
....	2080	41 13 00	66 21 50	55	46°; gy. S.	Sept. 4	1	......
5370	2085	40 05 00	70 34 45	70	50°; bu. M.	Sept. 20	6*l.*	0
5373	2086	40 05 05	70 35 00	69	52½°; bu. M. gy. S.	Sept. 20	2	0
5418	2086	40 05 05	70 35 00	69	52½°; bu. M. gy. S.	Sept. 20	3	0
7010	2086	40 05 05	70 35 00	69	52½°; bu. M. gy. S.	Sept. 20	1*s.*	
5362	2092	39 58 35	71 00 30	197	45°; gn. M.	Sept. 21	9*l.*	0
5363	2087	40 06 50	70 34 15	65	50°; gn. M. S.	Sept. 20	22	
5355	2088	39 59 15	70 36 30	143	48°; yl. S.	Sept. 20	5	0
5360	2090	39 59 40	70 41 10	140	48½°; S. brk. S.	Sept. 20	21	9
5354	2091	40 01 50	70 59 00	117	49°; gn. M.	Sept. 21	26 (5 E.)	12
5416	2092	39 58 35	71 00 30	197	45°; gn. M.	Sept. 21	1	0
....	1156	40 13 00	70 29 00	60	45°; M.	Aug. 23	1	0
....	1157	40 14 00	70 29 15	62	45°; sft. M.	Aug. 23	1	0
....	1163	40 35 30	70 41 00	31	46°; S. M.	Aug. 23	1	0

* Under this and the following species of *Eupagurus*, in the column giving the number of specimens, E indicates that the carcinœcia were formed of *Epizoanthus Americanus*.
† Labeled "Station 2014 to 2017," but evidently from the first of these stations.
‡ The single small specimen was undoubtedly really from Station 2014.

EUPAGURUS PUBESCENS Brandt ex Kröyer.

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens— No.	Specimens— With eggs.
		° ′ ″	° ′ ″	*Fath.*				
....	2057	42 01 00	68 00 30	86	brk. Sh.	Aug. 30	3, 1 E.	......
7082	2058	41 57 30	67 58 00	35	50°; gy. S.	Aug. 30	5, 1 E.	......
....	2081	41 10 20	66 30 20	50	46°; wh. S.	Sept. 4	1	......
....	2082	41 09 50	66 31 50	49	46½°; crs. S. G.	Sept. 4	5	......
7009	2087	40 06 50	70 34 15	65	50°; gn. M. S.	Sept. 20	2*s.* E.	......
5426	2087	40 06 50	70 34 15	65	50°; gn. M. S.	Sept. 20	1*s.*	......
....	1159	40 20 00	70 35 00	55	44°; sft. M.	Aug. 23	1	0
....	1163	40 35 30	70 41 00	31	46°; S. M.	Aug. 23	3	0
....	1165	40 50 00	70 49 00	32	45°; gy. S.	Aug. 23	2	0

EUPAGURUS KRÖYERI Stimpson.

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens— No.	Specimens— With eggs.
		° ′ ″	° ′ ″	*Fath.*				
7139	2004	37 19 45	74 26 00	98	gn. M. S.	Mar. 23	2*s*. E.	0
5627	2012	36 41 15	74 39 50	66	....	Apr. 30	1*s*.	......
7145	2025	40 02 05	70 27 00	239	40½° ; gn. M.	May 25	3*s*.	......
5632	2026	40 04 00	70 28 50	131	48° ; gn. M.	May 25	1*s*. E.	......
....	2057	42 01 00	68 00 30	86	brk. Sh.	Aug. 30	10	......
....	2058	41 57 30	67 58 00	35	50° ; gy. S.	Aug. 30	5	0
....	2060	42 10 00	66 46 15	123	brk. S.	Aug. 31	4	......
....	2062	42 17 00	66 37 15	150	42° ; S. G.	Aug. 31	15	0
....	2063	42 23 00	66 23 00	141	46° ; S. crs. G.	Aug. 31	1	......
....	2068	42 03 00	65 48 40	131	42° ; S. fne. G.	Sept. 1	3	......
....	2079	41 13 00	66 19 50	75	45° ; wh. S.	Sept. 4	1	......
....	2080	41 13 00	66 21 50	55	46° ; gy. S.	Sept. 4	4*l*.	......
5374	2086	40 05 05	70 35 00	69	52½°; bu. M. gy. S.	Sept. 20	4*s*. E.	......
7008	2087	40 06 50	70 34 15	65	50° ; gn. M. S.	Sept. 20	1*s*. E.	......
7006	2090	39 59 40	70 41 10	140	48½° ; S. brk. S.	Sept. 20	1*s*.	......
7003	2091	40 01 50	70 59 00	117	49° ; gn. M.	Sept. 21	5*s*. E.	......

EUPAGURUS LONGICARPUS Stimpson ex Say.

Station 2016, May 5, north lat. 37° 31′, west long. 74° 52′ 36″, 19 fathoms—1 specimen (5597).

EUPAGURUS POLLICARIS Stimpson ex Say.

(Plate IV, Fig. 4.)

Station 2015, May 5, north lat. 37° 31′, west long. 74° 53′ 30″, 19 fathoms—2 young (7136). Station 2017, May 5, north lat. 37° 30′ 48″, west long. 74° 51′ 29″, 18 fathoms—1 young (7140).

CATAPAGURUS SHARRERI A. M.-Edwards.

Smith, Proc. National Mus., vi, p. 31, pl. 4, fig. 5, 1883.

(Plate IV, Figs. 1, 2.)

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens— ♂	Specimens— ♀	Specimens— With eggs.
		° ′ ″	° ′ ″	*Fath.*					
5525	2004	37 19 45	74 26 00	98	gn. M. S.	Mar. 23	14	2	......
5541	2004	37 19 45	74 26 00	98	gn. M. S.	Mar. 23	1		......
5540	2005	37 18 11	74 27 36	78	bu. M. S. Sh.	Mar. 23	2		......
7138	2026	40 04 00	70 28 50	131	48°; gn. M.	Mar. 25	7		......
5376	2090	39 59 40	70 41 10	140	48½°; gn. S. Sh.	Sept. 20	4		......
7004	2091	40 01 50	70 59 00	117	49°; gn. M.	Sept. 21	2		......

In the measurements of one of Milne-Edwards's type specimens given in my paper above referred to there are two errors of 10 millimeters

each: the length from front of carapax to tip of pleon should be 13.0 in place of 23.0, and the length of the left cheliped should be 21.0 in place of 31.0.

PARAPAGURUS PILOSIMANUS Smith.

Trans. Conn. Acad. New Haven, v, p. 51, 1879; Proc. National Mus., iii, p. 428, 1881; Bull. Mus. Comp. Zool., x, p. 20, pl. 2, figs. 4–4[d], 1882; Proc. Nation Mus., vi, p. 33, pl. 5, figs, 3–5, pl. 6, figs. 1–4[a], 1883.

*Specimens examined.**

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens— ♂	Specimens— ♀	Specimens— With eggs.
		° ′ ″	° ′ ″	*Fath.*					
....	2036	88 52 40	69 24 40	1,735	38°; glb. O.	July 18	1E.		......
7114	2037	38 53 00	69 23 30	1,731	38°; glb. O.	July 18	5*	7*	5
7115	2038	38 30 30	69 08 25	2,033	glb. O.	July 26	6E.		......
5457	2097	37 56 20	70 57 30	1,917	glb. O.	Oct. 1	2E.	3E.	1
5458	2097	37 56 20	70 57 30	1,917	glb. O.	Oct. 1	1U.		......
5466	2097	37 56 20	70 57 30	1,917	glb. O.	Oct. 1		2	2
5484	2098	37 40 30	70 37 30	2,221	glb. O.	Oct. 1	1U.	5E.	4

*In the column giving the number of specimens, E indicates that the carcinœcia were formed of a species of *Epizoanthus* distinct from either *E. Americanus* or *E. paguriphilus*, and U that the carcinœcia were a species *Urticina*. Of the twelve specimens from Station 2037, four were in the *Epizoanthus*, two in *Urticina*, three in naked gastropod shells, and the others without carcinœcia.

As the above table shows, the Albatross dredgings have very greatly extended the bathymetrical range of this species. It had previously been taken in 250 to 640 fathoms. This increased range in depth is apparently accompanied by a change in the kind of carcinœcia inhabited. All the earlier specimens, over four hundred in number, were found in carcinœcia of *Epizoanthus paguriphilus* Verrill, while the deep-water specimens were either in a very different species of *Epizoanthus*, in naked gastropod shells, or in an actinian closely resembling, if not identical with, *Urticina consors* Verrill, which often serves for the carcinœcium of the next species.

SYMPAGURUS PICTUS Smith.

Proc. National Mus., vi, p. 37, pl. 5, figs. 2, 2a; pl. 6, figs. 5–8, 1883.

(Plate IV, Fig. 3.)

Station 2089, September 20, north lat. 39° 58′ 50″, west long. 70° 39′ 40″, 168 fathoms, gray sand, temperature 45°—1 female (5366) in an *Urticina* with a nucleus of *Epizoanthus*.

GALATHEIDEA.

MUNIDA CARIBÆA? Smith.

Bull. Mus. Comp. Zool., x, p. 22, pl. 10, fig. 1, 1882; Proc. National Mus., vi, p. 40, pl. 3, fig. 11, 1883.

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens— No.	Specimens— With eggs.
		° ′ ″	° ′ ″	*Fath.*				
5514	2004	37 19 45	74 26 00	98	gn. M. S.	Mar. 23	64	2
5517	2004	37 19 45	74 26 00	98	gn. M. S.	Mar. 23	5	0
5521	2004	37 19 45	74 26 00	98	gn. M. S.	Mar. 23	28	0
5515	2005	37 18 11	74 27 36	78	bu. M. S. Sh.	Mar. 23	68	3
5529	2005	37 18 11	74 27 36	78	bu. M. S. Sh.	Mar. 23	4	0
5601	2011	36 38 30	74 40 10	81	S. brk. Sh.	Apr. 30	28	5
5598	2012	36 41 15	74 39 50	66	....	Apr. 30	23	0
5572	2026	40 04 00	70 28 50	131	48°; gn. M.	May 25	1	0
5579	2031	39 29 00	72 19 55	74	gy. M.	May 26	1	0
5423	2086	40 05 05	70 35 00	69	52½°; bu.M.gy.S.	Sept. 20	1*y*.	0
5399	2086	40 05 05	70 35 00	69	52½°; bu.M.gy.S.	Sept. 20	1*y*.	0

GALACANTHA ROSTRATA A. M.-Edwards.

Bull. Mus. Comp. Zool., Cambridge, viii, p. 52, 1880; Smith, *ibid.*, x, p. 21, pl. 9, figs. 2, 2ᵃ, 1882.

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens— ♂	Specimens— ♀	Specimens— With eggs.
		° ′ ″	° ′ ″	*Fath.*					
7078	2052	39 40 05	69 21 25	1,098	45°; glb. O.	Aug. 1		1*l*.	1
7079	2052	39 40 05	69 21 25	1,098	45°; glb. O.	Aug. 1	1*s*.		......
7080	2084	40 16 50	67 05 15	1,290	40°; bu. M. S.	Sept. 5	1	1	......
5483	2095	39 29 00	70 58 40	1,342	glb. O.	Sept. 30	1	2	1

Soon after preservation in alcohol and before the colors had changed materially from those of life, the large specimen, 7078, was dark-purplish red, except the flagella of the antennæ, which were lighter red than the body (the flagella of the antennulæ were wanting), and the eyes, which were nearly white.

The eggs are about 3 mm in diameter in freshly-preserved alcoholic specimens.

Three specimens give the following measurements in millimeters:

Number of specimen	7079	5485	7078
Station	2052	2095	2052
Sex	♂	♀	♀
Length from tip of rostrum to tip of telson	26.0	66.0	96.0
Length of carapax to bases of rostral spines	12.7	31.0	45.0
Greatest breadth excluding spines	9.8	30.0	37.0
Greatest breadth including spines	11.0	22.4	39.5
Length of rostrum above its lateral spines	3.1	9.0	8.0
Length of gastric spine	3.1	9.2	9.1
Greatest breadth pleon	7.8	21.9	35.0
Greatest diameter of eye	1.2	3.0	4.0
Length of cheliped	18.0	41.0	57.0
Length of chela	7.0	16.2	25.0
Length of dactylus	4.0	9.5	14.0
Length of first ambulatory peræopod	......	50.0	70.0
Length of posterior peræopod	......	29.0	49.0

GALACANTHA BAIRDII, sp. nov.

This species, which is represented by a single specimen (5717), is very distinct from either of the species described by A. Milne-Edwards, and readily distinguished by the long, slightly upturned, and laterally spinous rostrum, by the number and form of the lateral spines of the carapax, and by the terminal spines of the eye-stalks. In some of its characters the species is more like *Munidopsis* than *Galacantha*, and it is possible that the genera should be united.

Female.—The carapax is broadest at the branchial regions, very slightly narrowed toward the front, and strongly convex transversely, and the length of the lateral margin is a little greater than the breadth. The anterior margins are oblique, and the front gradually narrowed into a long, rather slender, and slightly upturned rostrum, armed along the middle of either edge with three teeth directed outward and forward. The antero-lateral angle is armed with a slender spiniform tooth, turned forward, and back of this the lateral margin is armed with either two or three spines: a large one on the front of the hepatic region and slightly above the spine of the antero-lateral angle; another, but much smaller spine, just back of the first, on the hepatic region of the right side only; and one, about as large as the antero-lateral, on the edge of the branchial region, just back of the shallow cervical suture. There is a pair of large spines on the front of the gastric region, a pair of smaller ones nearer together on the posterior part of the gastric region, and between these two pairs a pair of still smaller ones. The front of the cardiac region is slightly elevated, and armed with a pair of spines like the posterior gastric, and just back of these there is a small median spine. The raised posterior margin of the carapax is armed with four or five small vertical spines either side. The surface of the branchial regions is roughened with numerous short transverse rugæ; other parts of the surface are more or less granular or minutely tuberculous, and the whole surface of the carapax, pleon, and peræopods are more or less thickly clothed with short hairs.

The eyes are very much smaller than in *G. rostrata* and colorless in the alcoholic specimen, and the eye-stalk is prolonged on the dorsal side beyond the cornea in a slender horizontal spine as long as the diameter of the eye.

The stout first segment of the peduncle of the antennula is armed distally with five sharp spines, two above and three below the insertion of the second segment. The second segment of the peduncle of the antenna is armed with a triangular tooth below and a spiniform tooth on the outer side; the third segment is armed with two spiniform teeth situated as on the second segment; the fourth with three large spines above and two or three minute ones beneath; and the fifth or last with two small teeth above. The flagella of the antennæ are nearly as in *G. rostrata*.

The second gnathopods are nearly as in *G. rostrata* except the merus,

which is very little stouter than the ischium and without prominent teeth, having instead two or three small and low spiniform tubercles.

The chelipeds are longer than the carapax including the rostrum, rather stouter and much more spiney than in *G. rostrata*: the ischium, merus and carpus are armed along the rounded angles and at the distal ends with spines of which the dorsal and distal on the merus and carpus are large. The chela is longer than the merus, a third as broad as long, the digits are stout and longer than the body of the chela, of which the edges are rounded, the inner armed with two slender spines and the outer with two or three short spinules. The three pairs of ambulatory peræopods are nearly alike, stout and longer than the chelipeds; the meri and carpi are spiney, as in the chelipeds, though the spines are somewhat smaller; the propodi are rough, with short setæ, but not spiney; and the dactyli are stout, slightly curved, terminate in acute chitinous tips, and are armed along the lower edge with a series of spiniform teeth. The posterior peræopods are nearly as in *G. rostrata*.

The pleon is about as broad as the carapax, only very slightly narrowed posteriorly, and the dorsum is transversely rounded and devoid of longitudinal carinæ or teeth. The first and second somites have two transverse ridges each on the middle of the dorsum, and there is a single similar but less conspicuous ridge on the front edge of the third. The lateral edges of all the pleura are obtusely rounded.

The telson, uropods, and pleopods are as in *G. rostrata*.

The eggs are of the same form and size as in *G. rostrata*.

Measurements in millimeters.

Length from tip of rostrum to tip of telson	82.0
Length of carapax including rostrum	44.5
Length of rostrum	18.0
Greatest breadth of carapax including spines	25.3
Breadth at bases of antero-lateral spines	19.0
Breadth at branchial regions	24.0
Length of eye-stalk including spine	5.5
Length of spine	1.8
Diameter of eye	1.8
Length of cheliped	50.0
Length of chela	18.5
Breadth of chela	6.4
Length of dactylus	10.8
Length of first ambulatory peræopod	64.0
Length of propodus	17.0
Length of dactylus	12.5
Length of posterior peræopod	30.0
Length of telson	11.0
Breadth of telson	14.5
Length of inner lamella of uropod	9.3
Breadth of inner lamella of uropod	7.5
Length of outer lamella of uropod	10.2
Breadth of outer lamella of uropod	7.5

Station 2106, November 6, north lat. 37° 41′ 20″, west long. 73° 03′ 20″, 1,497 fathoms, globigerina ooze, temperature 42½°.

The species is named in honor of G. W. Baird, the accomplished chief engineer of the Albatross.

MUNIDOPSIS CURVIROSTRA Whiteaves.

Amer. Jour. Sci., III, vii, p. 212, 1874; Report on further deep-sea dredging operations in the Gulf of Saint Lawrence [in 1873], p. 17, 1874. Smith, Bull. Mus. Comp. Zool., Cambridge, x, p. 21, pl. 8, figs. 2, 3, 3*a*, 1882.

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens— ♂	Specimens— ♀	Specimens— With eggs.
		° ′ ″	° ′ ″	*Fath.*					
5580	2018	37 12 22	74 20 04	788	....	May 7		1	1
7058	2051	39 41 00	69 20 20	1,106	39°; bu. M., glb. O.	Aug. 1		1	1
7059	2052	39 40 05	69 21 25	1,098	45°; glb. O.	Aug. 1	1*s.*	1	1
7060	2072	41 53 00	65 35 00	858	39°; gy. M.	Sept. 2	2		......
7061	2076	41 13 00	66 00 50	906	bu. M.	Sept. 4	2	1	0
7062	2077	41 09 40	66 02 00	1,255	39°; bu. M.	Sept. 4	2	1	1
7063	2078	41 12 50	66 12 20	499	40°; gy. S.	Sept. 4	2	1	0
7064	2079	41 13 00	66 19 50	75	45°;	Sept. 4		1	0
5390	2079	41 13 00	66 19 50	75	45°;	Sept. 4		1	1
7065	2084	40 16 50	67 05 15	1,290	40°;	Sept. 5	1		......
5337	2094	39 44 30	71 04 00	1,022	38½°; F. S. M.	Sept. 21	1		......
5403	(?)	......	....	....	....	....		1*s.*	0
5715	2115	35 49 30	74 34 45	843	39°; M., fne. S.	Nov. 11	4		......
5716	2116	35 45 23	74 31 25	888	39°; bu. M., fne. S.	Nov. 11	1	1	1

Three specimens give the following measurements in millimeters:

Number of specimen	7059	7058	7059
Station	2052	2051	2052
Sex	♂	♀	♀
Length from tip of rostrum to tip of telson	22.0	32.0	38.0
Length of carapax, including rostrum	13.5	18.0	21.7
Length of rostrum	6.5	8.0	10.6
Greatest breadth of carapax	5.9	8.3	9.7
Length of cheliped	17.0	25.0	27.0
Length of chela	6.0	8.7	10.3
Length of dactylus	2.9	4.8	5.2
Length of first ambulatory peræopod	14.5	20.0	21.7

The eggs are very few in number—between thirty and forty each in the females measured—and in recently-preserved alcoholic specimens about 0.80^{mm} by 0.75^{mm} in greater and less diameter.

MACRURA.

ERYONTIDÆ.

PENTACHELES SCULPTUS Smith.

Polycheles sculptus Smith, Ann. Mag. Nat. Hist. London, V, v, p. 269, April, 1880; Proc. National Mus., ii, p. 345, pl. 7, 1880.

Pentacheles sculptus Smith, Bull. Mus. Comp. Zool., x, p. 23, pls, 3, 4, 1882.

Station 2115, November 11, north lat., 35° 49′ 30″, west long., 74° 34′ 45″, 843 fathoms, mud and sand, temperature 39°—3 young males (7141.)

Measurements of the largest of these specimens is given under the next species.

PENTACHELES NANUS, sp. nov.

This species is very closely allied to *P. sculptus* and will possibly prove to be only a dwarf deep-water variety of it, but the distinctive characters are well marked and very constant in all the large number of specimens seen.

The spines upon the carapax are much longer and more slender than in *P. sculptus* and differ in number. Including the very long and slender spine of the anterior angle, there are only five spines on the lateral margin in front of the cervical suture each side, while there are normally six in *P. sculptus*; on the middle line of the gastric region back of the two rostral spines there are, at nearly equal distances, first two single spines, one behind the other, then a pair close together, and lastly a single one, while in *P. sculptus* there is only one single spine between the rostral spines and the pair; the surface of the branchial region on both sides of the sublateral carina is armed with many small spines or spinules, and on the anterior part of the oblique ridge between the dorsal and sublateral carinæ there is one spine as large as the spines of the sublateral carina itself, while in *P. sculptus* the surface of the branchial region is unarmed and nearly smooth, except for the carinal and marginal spines. There is often a slender, horizontal median spine in front just beneath the rostral spines, but this is not a constant character.

The pleon is more deeply sculptured than in *P. sculptus*, and the dorsal carina very much higher, the recurved carinal teeth of the third, fourth, and fifth somites are very much longer and more slender, and reach far over the somites in front. The edges of the sulcated carina on the sixth somite, instead of being low and uniform as in *P. sculptus*, are very high and broken into several prominent teeth each side, with a stouter and higher tooth at the posterior end of the sulcus. The edges of the pleura of the second to the fifth somite are conspicuously armed with rather widely separated short spiniform teeth, while in *P. sculptus* they are entirely smooth, or, in small specimens, inconspicuously armed with obsolete teeth. In place of the slight median elevation near the middle of the telson of *P. sculptus* there is a sharp spiniform prominence, with occasionally a smaller secondary one just back of it.

In all the specimens seen the first peræopods (great chelipeds) are considerably shorter than in *P. sculptus*, but these appendages are subject to so much individual variation in size that this will very likely not prove a constant character.

Males less than 50^{mm} in length are sexually adult, while in *P. sculptus* males considerably larger than this are not adult, the first pleopods being very small and weak, and the secondary stylet at the base of the inner ramus of the second pleopods only about half as long as the other stylet.

In the accompanying table measurements of five adult specimens of this species and of a single immature specimen of *P. sculptus* are given together.

Measurements in millimeters.

	Pentacheles nanus.					P. sculptus.
Station	2106	2052	2116	2077	2102	2115
Sex	♀	♀	♀	♂	♂	♂
Length from front of carapax to tip of telson	46.0	53.0	87.0	45.0	55.0	54.0
Length of carapax along median line	19.2	22.0	35.6	19.0	22.8	23.2
Breadth of carapax between spines of anterior angles	8.2	9.7	17.2	8.0	10.0	11.1
Greatest breadth, including spines	13.5	15.5	26.5	13.2	17 0	16.0
Length of first peræopod	40.0	49.0	73+	38.0	52.0	61.0
Length of merus	10.8	14.5	25.0	11.1	15.0	19.0
Length of carpus	6.0	8.0	12.0	5.3	7.5	11.4
Length of chela	13.0	15.5	17+	12.0	16.0	20.0
Length of dactylus	7.8	10.0	......	7.5	9.2	12.0
Length of second peræopod	16.5	20.0	34.0	16.0	20.0	20.0
Length of merus	4.0	4.9	8.8	4.1	5.0	5.3
Length of carpus	2.5	3.2	5.4	2.3	3.2	3.2
Length of propodus	6.1	7.5	12.5	6.0	7.9	7.5
Length of dactylus	3.0	3.3	5.3	2.7	3.5	3.3
Length of fifth peræopod	10.0	14.0	23.0	10.0	13.0	12.0
Length of propodus	3.1	4.3	7.5	3 2	4.2	3.2
Length of dactylus	0.9	1.1	2.1	0.9	1.1	0.9
Length of pleon	27.0	31.0	52.0	26.0	33.0	30.0
Greatest breadth at second somite	10.1	12.9	24.0	10.1	13.3	12.6
Greatest breadth at sixth somite	5.6	7.0	11.8	5.5	7.2	6.8
Length of telson	8.5	10.2	16.5	8.3	11.1	10.0
Breadth of telson	4.2	5.1	8.0	4.1	5.2	4.6

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens— ♂	Specimens— ♀	Specimens— With eggs.
		° ′ ″	° ′ ″	Fath.					
7142	2035	39 26 12	70 02 37	1,362	38°; glb. O.	July 17		1	0
....	2051	39 41 00	69 20 20	1,106	39°;bu.M.glb.O	Aug. 1	1		......
....	2052	39 40 05	69 21 25	1,098	45°; glb. O.	Aug. 1		1	0
7143	2077	41 09 40	66 02 00	1,255	39°; bu. M.	Sept. 4	6		......
7144	2084	40 16 50	67 05 15	1,290	40°; bu. M. S.	Sept. 5	1	1	0
5481	2095	39 29 00	70 58 40	1,342	glb. O.	Sept. 30		1	0
5446	2096	39 22 20	70 52 20	1,451	37½°; glb. O.	Sept. 30	1		......
5447	2097	37 56 20	70 57 30	1,917	glb. O.	Oct. 1	1		......
5714	2102	38 44 00	72 38 00	1,209	39°; glb. O.	Nov. 5	3	1	0
5712	2103	38 47 20	72 37 00	1,091	39°; glb. O.	Nov. 5	1	1	0
5711	2105	37 50 00	73 03 50	1,395	41°; glb. O.	Nov. 6		1y.	0
5710	2106	37 41 20	73 03 20	1,497	42½°; glb. O.	Nov. 6		1	0
5713	2111	35 09 50	74 57 40	938	gn. M.	Nov. 9		1	0
5709	2115	35 49 30	74 34 45	843	39°	Nov. 11	1	2	0
5708	2116	35 45 23	74 31 25	888	39°; bu. M.	Nov. 11		3	0

PENTACHELES DEBILIS, sp. nov.

This is represented by two immature males only, but it is apparently so different from either of the foregoing species or any of those described by Bate or Milne-Edwards, that I venture to describe it. Of the described species it is probably most nearly allied to *P. validus* A. M.-Edwards.

The dorsal surface of the carapax is much flatter than in *P. sculptus* or *P. nanus*, broader posteriorly, the greatest breadth being a little back of the middle branchial regions, and the sublateral carinæ of the branchial regions are indistinct or wanting. The orbital sinuses are deep, very much narrowed posteriorly, and the inner angles project forward in a spine-tipped angle far in advance of the rostrum. Including the

slender spine of the anterior angle the lateral margin in front of the cervical suture is armed with eight to ten slender spines, much smaller than in *P. sculptus.* The margin of the hepatic region back of the cervical suture is armed with four or five still smaller spines, and that of the branchial region with twenty to twenty-five minute spines. There are two short rostral spines, and just back of the middle of the gastric region two similar but slightly smaller ones on the dorsal carina, which is low, narrow, and armed the whole length of the carapax with a somewhat irregular double line of short and crowded spinules. There are two or three prominent spines back of the orbital sinuses on either side of the gastric region, and the whole surface is armed with many minute spinules and with short hairs. The ophthalmic lobes are each armed in front with a conspicuous spine. There is a single stout spine on the outer margin of the proximal segment of the peduncle of the antennula, which is otherwise essentially as in *P. sculptus*, as are also the antennæ.

The first peræopods are imperfect and their chelæ wanting in both specimens, but the ischium, merus, and carpus are nearly as in *P. nanus*. In the posterior peræopods the propodus is a little longer than in *P. sculptus* or *P. nanus*, but the propodal digit is shorter, being only about a third as long as the dactylus, which is about three-eighths as long as the propodus.

The first five somites of the pleon are perceptibly, though very inconspicuously, carinated, and on the second, third, and fourth somites there is a narrow sulcus each side, extending from near the carina outward and backward to the articulation with the succeeding somite. The pleura are of nearly the same form as in *P. sculptus*, but are nearly smooth externally, and the edges are wholly unarmed. The sixth somite is rounded and smooth above.

The telson is a little longer and more slender toward the tip than in *P. sculptus* or *P. nanus*, and has a low triangular elevation near the base.

Measurements in millimeters.

Station	2084	2074
Length from front of carapax to tip of telson	45. 0	46. 0
Length of carapax along median line	20. 0	20. 5
Breadth of carapax between spines of anterior angles	8. 2	8. 3
Greatest breadth including spines	14. 0	14. 3
Length of merus of first peræopod	12. 5	.....
Length of carpus of first peræopod	8. 4	.....
Length of second peræopod	16. 0	.....
Length of chela	5. 9	.....
Length of dactylus	2. 6	.....
Length of fifth peræopod	12. 0	13. 0
Length of propodus	3. 9	3. 8
Length of dactylus	1. 5	1. 3
Length of telson	9. 6	10. 0
Breadth of telson	4. 7	4. 9

Station 2074, September 3, north lat. 41° 43′, west long. 65° 21′ 50″, 1,309 fathoms, fine mud, temperature 40°—1 ♂ (7145). Station 2084, September 5, north lat. 40° 16′ 50″, west long. 67° 5′ 15″, 1,290 fathoms, blue mud and sand, temperature 40°—1 ♂ (7146).

CRANGONIDÆ.

CERAPHILUS AGASSIZII Smith.

Bull. Mus. Comp. Zool., x, p. 32, pl. 7, figs. 4-5a, 1882.

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens— ♂	Specimens— ♀	Specimens— With eggs.
		° ′ ″	° ′ ″	*Fath.*					
5538	2003	37 16 30	74 20 36	640	....	Mar. 23		5	3
5539	2003	37 16 30	74 20 36	640	....	Mar. 23	2*y.*	1	0
7096	2048	40 02 00	68 50 30	547	crs. S. M. G.	July 31	2		......
....	2072	41 53 00	65 35 00	858	39°; gy. M.	Sept. 2		2	1
7095	2076	41 13 00	66 00 50	906	bu. M.	Sept. 4	3 5*y.*		......
7097	2078	41 12 50	66 12 20	499	40°; gy. M. S.	Sept. 4	1*y.*		......
....	2083	40 26 40	67 05 15	959	40°; gy. M.	Sept. 5	1*y.*		......

CRANGON VULGARIS Fabricius.

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens— ♂	Specimens— ♀	Specimens— With eggs.
		° ′ ″	° ′ ″	*Fath.*					
5557	2015	37 31 00	74 53 30	19	S. Sh.	May 5		1	0
5560	2016	37 31 00	74 52 36	19	45½°; S. Sh.	May 5	2	2	2
5558	2017	37 30 48	74 51 29	18	45½°; S. Sh.	May 5		1	1

PONTOPHILUS NORVEGICUS M. Sars.

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens— ♂	Specimens— ♀	Specimens— With eggs.
		° ′ ″	° ′ ″	*Fath*					
5590	2025	40 20 05	70 27 00	239	40½°; gn. M.	May 25	1	3	0
5584	2027	39 58 25	70 37 00	197	43°; bu. M. S.	May 25		1	0
....	2053	42 02 00	68 27 00	105	bu. M.	Aug. 29		2	0
5358	2092	39 58 35	71 00 30	197	45°; gn. M.	Sept. 21		7	1

PONTOPHILUS BREVIROSTRIS Smith.

Proc. National Mus., iii, p. 435, 1881; Bull. Mus. Comp. Zool., x, p. 35, pl. 7, figs. 1-1b, 1882.

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens— ♂	Specimens— ♀	Specimens— With eggs.
		° ′ ″	° ′ ″	*Fath.*					
5531	2004	37 19 45	74 26 00	98	gn. M. Sh.	Mar. 23		3	3
5339	2086	40 05 05	70 35 00	69	52½°; bu. M. S.	Sept. 20	1	6	6
5421	2086	40 05 05	70 35 00	69	52½°; bu. M. S.	Sept. 20		5	3
7005	2086	40 05 05	70 35 00	69	52½°; bu. M. S.	Sept. 20		1	0
5387	2087	40 06 50	70 34 15	65	50°; gn. M. S.	Sept. 20		5	5

PONTOPHILUS ABYSSI, sp. nov.

This species is closely allied to *P. gracilis* (Bull. Mus. Comp. Zool., Cambridge, x, p. 36, pl. 7, figs. 2, 3, 1882), but is readily distinguished by the smaller and nearly colorless eyes, and by having two spines in place of one on the gastric region.

The carapax, including the rostrum, is more than twice as long as broad in the male, but broader proportionately in the female, and slightly carinated. The rostrum is about a fifth as long as the rest of the carapax, very slender, and armed near the base with two minute lateral teeth each side. There are three spines on the median line, two near together on the anterior part of the gastric region and one on the anterior part of the cardiac, and between the posterior gastric and cardiac spines the dorsal carina is very distinct, but not high. As in *P. gracilis*, there is a distinct hepatic spine and above and back of this another in the obscure lateral carina, but in addition there is a minute spine each side just back of the supraorbital fissure.

The eyes do not reach to the tip of the rostrum, are only very slightly compressed vertically, little more than half as large proportionately as in *P. gracilis*, the diameter being about a tenth the length of the carapax, and colorless in alcoholic specimens.

The characters of the articular appendages in general and of the pleon are so nearly like those of *P. gracilis* that further description is unnecessary. The number and arrangement of the branchiæ is the same as in *P. Norvegicus* and *brevirostris*, and as in the species of *Sabinea*.

Measurements in millimeters.

Station	2098	2097
Sex	♂	♀
Length from tip of rostrum to tip of telson	47.0	53+
Length of carapax, including rostrum	13.5	15.0
Length of rostrum	2.2	2.4
Breadth of carapax	6.0	......
Greatest diameter of eye	1.3	1.6
Length of antennal scale	7.5	8.5
Breadth of antennal scale	2.0	2.2
Length of first peræopod	16.0	19.0
Length of chela	6.1	7.0
Length of dactylus	2.5	2.9
Length of second peræopod	7.0	9.0
Length of third peræopod	20.0	......
Length of merus	5.0	......
Length of carpus	5.7	......
Length of propodus	3.2	......
Length of dactylus	1.7	......
Length of fourth peræopod	19.0	......
Length of merus	4.5	......
Length of carpus	2.6	......
Length of propodus	4.0	......
Length of dactylus	2.6	......
Length of sixth somite of pleon	8.0	9.5
Hight of sixth somite of pleon	3.0	3.5
Length of telson	9.0	......
Length of inner lamella of uropod	7.3	9.0
Breadth of inner lamella of uropod	1.5	1.7
Length of outer lamella of uropod	6.8	8.4
Breadth of outer lamella of uropod	2.0	2.3

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens— ♀	Specimens— ♂	Specimens— With eggs.
		° ′ ″	° ′ ″	Fath.					
7023	2097	37 56 20	70 57 30	1,917	glb. O.	Oct. 1	1		......
7025	2097	37 56 20	70 57 30	1,917	glb. O.	Oct. 1		1	1
7024	2098	37 40 30	70 37 30	2,221	glb. O.	Oct. 1	1		......

SABINEA PRINCEPS Smith.

Bull. Mus. Comp. Zool., x, p. 38, pl. 8, figs. 1–1b, 1882.

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens— ♂	Specimens— ♀	Specimens— With eggs.
		° ′ ″	° ′ ″	Fath.					
5533	2003	37 16 30	74 20 36	640	gn. M.	Mar. 23		2*l*.	0
....	2072	41 53 00	65 35 00	838	39°; gy. M.	Sept. 2	2 1*y*.	3	1
5681	2115	35 49 30	74 34 45	843	39°; M. fne. S.	Nov. 11	4*y*.	1	0
5694	2116	35 45 23	74 31 25	888	39°; bu.M.fne.S.	Nov. 11	1*y*.		......

SABINEA SARSII Smith.

Trans. Conn. Acad., New Haven, v, p. 59, pl. 11, figs. 6, 7, 8, 1879.

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens— ♂	Specimens— ♀	Specimens— With eggs.
		° ′ ″	° ′ ″	Fath.					
7073	2062	42 17 00	66 47 45	150	42°; S. G.	Aug. 31	1	17	17
....	2063	42 23 00	66 23 00	141	46°; S. crs. G.	Aug. 31	10	22	21
....	2064	42 25 40	66 08 35	122	crs. S. G.	Aug. 31	1	7	7
....	2067	42 15 25	65 48 40	122	46°; S. G.	Sept. 1	12	19	17
7072	2068	42 03 00	65 48 40	131	42°; S. fne. G.	Sept. 1	1	3	2

This species is closely allied to *S. septemcarinata* and has apparently been often confounded with it. It was described from a very few specimens from the Gulf of Maine, Le Have Bank, George's Banks, and the coast of Norway, and has not been taken on our coast since 1877. It apparently inhabits hard sandy and gravelly bottoms, while the *S. septemcarinata* is usually confined to soft or muddy bottoms.

GLYPHOCRANGONIDÆ, fam. nov.

Rhachocarinæ Smith, Bull. Mus. Comp. Zool., x, p. 45, 1882.

GLYPHOCRANGON A. M.-Edwards, Ann. Sci. nat., VI, xi, no. 4, p. 3, 1881.

Rhachocaris Smith, loc. cit., 1882.

Milne-Edwards's recently published figures of the species of his *Glyphocrangon* leave no reasonable doubt that the species were incorrectly de-

scribed, and that my genus is synonymous with his as indicated above. My *Rhachocaris Agassizii* is apparently synonymous with Milne-Edwards's *G. aculeatum*, but the two other species which I have described are apparently specifically distinct from the species figured by Milne-Edwards, and should stand as *Glyphocrangon sculptus* and *longirostris*.

The structural peculiarities of the genus pointed out in my original description are, I think, sufficient to warrant its separation from the typical Crangonidæ as a distinct family.

GLYPHOCRANGON SCULPTUS.

Rhachocaris sculpta Smith, Bull. Mus. Comp. Zool., x, p. 49, pl. 5, fig. 3, pl. 6, figs. 3–3[d], 1882.

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens— ♂	Specimens— ♀	Specimens— With eggs.
		° ′ ″	° ′ ″	Fath.					
7181	2035	70 02 37	39 26 12	1,362	38°; glb. O.	July 17		3	2
7182	2051	69 20 20	39 41 00	1,106	39°; bu.M.glb.O.	Aug. 1	2	1	1
7183	2052	69 21 25	39 40 05	1,098	45°; glb. O.	Aug. 1		1	1
7184	2077	66 02 00	41 09 40	1,255	39°; bu. M.	Sept. 4	1		......
5482	2095	70 58 40	39 29 00	1,342	glb. O.	Sept. 30	2		......
5637	2102	72 38 00	38 44 00	1,209	39°; glb. O.	Nov. 5	2		......
5671	2105	73 03 50	37 50 00	1,395	41°; glb. O.	Nov. 6	1		......
5675	2105	73 03 50	37 50 00	1,395	41°; glb. O.	Nov. 6	1		......

This species was originally described from a single female, which differed slightly from the usual form of the species as shown in the series of specimens enumerated above. The large vertically-compressed tooth at the extreme anterior end of the lateral lobe of the gastric region is usually more regularly acute than shown in the figures of the original specimen, and the anterior tooth of the middle lateral carina is acute instead of bidentate at tip. The males are considerably smaller than the females, but do not differ essentially, except in the usual modification of the pleopods and of the base of the major flagellum of the antennulæ.

PALÆMONIDÆ.

ALPHEINÆ.

HIPPOLYTE LILJEBORGII Danielssen.

H. securifrons Norman.

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens— ♂	Specimens— ♀	Specimens— With eggs.
		° ′ ″	° ′ ″	Fath.					
....	2062	42 17 00	66 37 15	150	42°; S. G.	Aug. 31		10	0
....	2063	42 23 00	66 23 00	141	46°; S. ors. G.	Aug. 31		3	0
....	2067	42 15 25	65 48 40	122	46°; S. G.	Sept. 1		1	0
....	2068	42 03 00	65 48 40	131	42°; S. fne. G.	Sept. 1		1	0
....	2079	41 13 00	66 19 50	75	45°; wh. S.	Sept. 4		2	0

HIPPOLYTE PUSIOLA Kröyer.

Station 2082, September 4, north lat. 41° 9′ 50″, west long. 66° 31′ 50″, 49 fathoms, coarse gravel and sand, temperature, 46½°—2 young (7070).

HIPPOLYTE POLARIS Ross.

Station 2067, September 1, north lat. 42° 15′ 25″, 65° 48′ 40″, 122 fathoms, sand and gravel, temperature, 46°—3 ♀.

HIPPOLYTE GRŒNLANDICA Miers ex J. C. Fabricius.

Station 2058, August 30, north lat. 41° 57′ 30″, west long. 67° 58′, 35 fathoms, gray sand, temperature 50°—1 ♀.

PANDALINÆ.

PANDALUS MONTAGUI Leach.

Pandalus Montagui Leach, "Edinburgh Encylopedia, vii, p. 432" (teste White), 1813 or 1814; American edition, vii, p. 271.—White, Catal. British Crust., vii, p. 41, 1850.—Smith, Trans. Conn. Acad., v, p. 87, 1879; Proc. National Mus., iii, p. 437 (under *P. leptocerus*), 1881.

Pandalus annulicornis Leach, Malacostraca Podophth. Britanniæ, pl. 40, March, 1815; Trans. Linn. Soc. London, xi, p. 346, 1815.

Pandalus levigatus Stimpson, Marine Invert. Grand Manan, p. 58, 1853.

One male (7066), 68^{mm} long, was taken at Station 2071, September 1, north lat. 41° 56′ 20″, west long. 65° 48′ 40″, 113 fathoms, pebbles.

PANDALUS PROPINQUUS G. O. Sars.

G. O. Sars, Vidensk-Selsk. Forhandl. Christiania, 1869, p. 148 (4); Ibid., 1871, 259 (16)—Smith, Proc. National Mus., iii, p. 437, 1881; Bull. Mus. Comp. Zool., x, p. 58, 1882.—A. M.-Edwards, Recueil fig. Crust. nouv., 1883.

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens— No.	Specimens— With eggs.
		° ′ ″	° ′ ″	Fath.				
5606	2025	40 02 05	70 27 00	239	41½°; M.	May 25	12	0
....	2062	42 17 00	66 37 15	150	42°; S. G.	Aug. 31	9 *l*	0
....	2067	42 15 25	65 48 40	122	46°; S. G.	Sept. 1	6	0
7007	2092	39 58 35	71 00 30	197	45°; gn. M.	Sept. 21	2	0

PANDALUS BOREALIS Kröyer.

Station 2053, August 29, north lat. 42° 2′, west long. 68° 27′, 105 fathoms, blue mud—89 specimens, of which 15 were carrying eggs.

PANDALUS LEPTOCERUS Smith.

Proc. National Mus., iii, p. 437, 1881; Bull Mus. Comp. zool., x, p. 58, 1882. A. M.-Edwards, Recueil fig. Crust. nouv., 1883.

(Plate V, Fig. 1.)

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens— ♂	Specimens— ♀	Specimens— With eggs.
		° ′ ″	° ′ ″	*Fath.*					
5559	2017	37 30 48	74 51 29	18	45½°; S. Sh.	May 5		1	1
5552	2020	37 37 50	74 15 30	143	S. bu. M.	May 21	5		0
5561	2026	40 04 00	70 28 50	131	48°; M.	May 25	1		0
5569	2031	39 29 00	72 19 55	74	gy. M.	May 26	1		0
5566	2032	39 29 00	72 19 40	73	gy. M.	May 26	3		0
....	2058	41 57 30	67 58 00	35	50°; gy. S.	Aug. 30	94		......
7069	2059	42 05 00	66 46 15	41	bu. M. S.	Aug. 31	2		0
....	2061	42 10 00	66 47 45	115	40°; bu. M. gy. S.	Aug. 31	600		0
....	2064	42 25 40	66 08 35	122	crs. S. G.	Aug. 31	7*l.*		......
....	2079	41 13 00	66 19 50	75	45°; wh. S.	Sept. 4	78		......
7071	2080	41 13 00	66 21 50	55	46°; gy. S.	Sept. 4	2		0
....	2081	41 10 20	66 30 20	50	46°; wh. S.	Sept. 4	600		0
7068	2082	41 09 50	66 31 50	49	46½°; crs. G. S.	Sept. 4	1		0
5377	2085	40 05 00	70 34 45	70	50°; bu. M.	Sept. 20	7		1
5357	2086	40 05 05	70 35 00	69	52½°; bu. M. gy. S.	Sept. 20	57		21
5412	2086	40 05 05	70 35 00	69	52½°; bu. M. gy. S.	Sept. 20	4		......
5348	2087	40 06 50	70 34 15	65	50°; gn. M. S.	Sept. 20	86		......
5424	2087	40 06 50	70 34 15	65	50°; gn. M. S.	Sept. 20	1		......
5365	2088	39 59 15	70 36 30	143	48°; yl. S.	Sept. 20	2*l.*		......
5368	2088	39 59 15	70 36 30	143	48°; yl. S.	Sept. 20	2		......
5382	2088	39 59 15	70 36 30	143	48°; yl. S.	Sept. 20	......	......	......
5383	2088	39 59 15	70 36 30	143	48°; yl. S.	Sept. 20	......	......	......
5414	2088	39 59 15	70 36 30	143	48°; yl. S.	Sept. 20	36		1
5413	2089	39 58 50	70 39 40	168	45°; gy. S.	Sept. 20	75		29
5415	2089	39 58 50	70 39 40	168	45°; gy. S.	Sept. 20		1	1
5356	2090	39 59 40	70 41 10	140	48½°; S. brk. S.	Sept. 20	125		......
5417	2090	39 59 40	70 41 10	140	48½°; S. brk. S.	Sept. 20	10		0
5359	2091	40 01 50	70 59 00	117	49°; gn. M.	Sept. 21	52		11
5396	2091	40 01 50	70 59 00	117	49°; gn. M.	Sept. 21	1		......
5861	2092	39 58 35	71 00 30	197	45°; gn. M.	Sept. 21	3	7	7
....	1156	40 13 00	70 29 00	60	45°; M.	Aug. 23	106		1
....	1157	40 14 00	70 29 15	62	45°; sft. M.	Aug. 23		1	1
....	1158	40 16 00	70 31 00	62	45°; sft. gn. M.	Aug. 23	3		0
....	1159	40 20 00	70 35 00	55	44°; sft. M.	Aug. 23	19		0
....	1160	40 24 00	70 35 00	41	43°; bk. M.	Aug. 23	38		0
....	1162	40 32 00	70 39 00	45	46½°; bk. M.	Aug. 23	15		0
....	1163	40 35 30	70 41 00	31	46°; S. M.	Aug. 23	3		0

NEMATOCARCININÆ.

NEMATOCARCINUS ENSIFERUS.

Eumiersia ensifera Smith, Bull. Mus. Comp. Zool., x, p. 77, pl. 13, figs. 1-9, 1882.

(Plate VII, Fig. 1.)

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens— ♂	Specimens— ♀	Specimens— With eggs.
		° ′ ″	° ′ ″	*Fath.*					
5553	2030	39 29 45	71 43 00	588	bu. M.	May 26	1		......
7091	2035	39 26 12	70 02 37	1,362	38°; glb. O.	July 17	7	11	3
7092	2035	39 26 12	70 02 37	1,362	38°; glb. O.	July 17		1	0
7093	2036	38 52 40	69 24 40	1,735	38°; glb. O.	July 18	4	3	0
....	2037	38 53 00	69 23 30	1,731	38°; glb. O.	July 18	28	16	0
....	2038	38 30 30	69 08 25	2,033	glb. O.	July 26		2	0
....	2041	39 22 50	68 25 00	1,608	38°; glb. O.	July 30	2	2	0
....	2042	39 33 00	68 26 45	1,555	38½°; glb. O.	July 30	2	1	0
....	2043	39 49 00	68 28 30	1,467	38½°; glb. O.	July 30	3	3	0
....	2051	39 41 00	69 20 20	1,106	39°; bu. M. glb. O.	Aug. 1	4	3	0
....	2052	39 40 05	69 21 25	1,098	45°; glb. O.	Aug. 1	4	4	......
....	2074	41 43 00	65 21 50	1,309	40°; fne. S. M.	Sept. 3		2	1
....	2077	41 09 40	66 02 00	1,255	39°; bu. M.	Sept. 4	2	1	0
....	2084	40 16 50	67 05 15	1,290	40°; bu. M. S.	Sept. 5		2	0
5351	2094	39 44 30	71 04 00	1,022	38½°; F. S. M.	Sept. 21	7*s.*		0
5471	2095	39 29 00	70 58 40	1,342	glb. O.	Sept. 30	5	9	3
5472	2096	39 22 20	70 52 20	1,451	37½°; glb. O.	Sept. 30	3	5	1
5455	2096	39 22 20	70 52 20	1,451	37½°; glb. O.	Sept. 30	2		......
5468	2096	39 22 20	70 52 20	1,451	37½°; glb. O.	Sept. 30		2	1
5470	2096	39 22 20	70 52 20	1,451	37½°; glb. O.	Sept. 30	3	3	2
5453	2097	37 56 20	70 57 30	1,917	glb. O.	Oct. 1	2	1	0
5461	2097	37 56 20	70 57 30	1,917	glb. O.	Oct. 1	2	1	0
5474	2097	37 56 20	70 57 30	1,917	glb. O.	Oct. 1	1*y.*		......
5636	2102	38 44 00	72 38 00	1,209	39°; glb. O.	Nov. 5		1	0
5638	2102	38 44 00	72 38 00	1,209	39°; glb. O.	Nov. 5		2	1
5641	2102	38 44 00	72 38 00	1,209	39°; glb. O.	Nov. 5	1	1	0
5634	2103	38 47 20	72 37 00	1,091	39°; glb. O.	Nov. 5	2*s.*	4	0
5672	2105	37 50 00	73 03 50	1,395	41°; glb. O.	Nov. 6	1		......
5689	2105	37 50 00	73 03 50	1,345	41°; glb. O.	Nov. 6	5	6	1
7135	2106	37 41 20	73 03 20	1,497	42½°; glb. O.	Nov. 6		1	0
5686	2106	37 41 20	73 03 20	1,497	42½°; glb. O.	Nov. 6	1	2	0
5642	2111	35 09 50	74 57 40	938	M.	Nov. 9	2		......
5650	2111	35 09 50	74 57 40	938	M.	Nov. 9		1	0
5680	2115	35 49 30	74 34 45	843	39°; M.	Nov. 11	1*s.* 7*y.*	2*s.*	0
5684	2116	35 45 23	74 31 25	888	39°; M.	Nov. 11	5*s.* 3*y.*	13*s.*	0

The recently-published figures (Recueil de figures de Crustacés nouveaux ou peu connus) show that my *Eumiersia* is apparently synonymous with A. Milne-Edwards's *Nematocarcinus* (Ann. Sci. Nat. Zool., VI, ix, No. 4, p. 14, 1881), although the type species of the two genera are evidently distinct. The genus resembles *Pandalus* in the external form of the carapax and abdomen, agrees with it essentially in the structure of the oral appendages, and has the same number and arrangement of branchiæ and epipods. The form of the first and second peræopods, and the presence of exopods at the bases of the first four pairs of peræopods are more like *Acanthephyra* than *Pandalus*, but the peræopods are all exceedingly long and slender, and the three last pairs are very nearly alike and peculiarly modified at the extremities. The mandibles, though essentially as in *Pandalus*, are stouter and have larger molar processes, while the ventral processes are very thin, more expanded, and with broader serrate tips, thus approaching somewhat to the struct-

ure in *Acanthephyra*, as do the palpi, which are much stouter than in the typical species of *Pandalus*.

The following description of the external parts of my species is somewhat modified from the original description, based on imperfect specimens:

The carapax is as broad as high, with the cervical suture indicated by a distinct sulcus from the dorsum to the upper part of the hepatic region either side, where the sulcus terminates in a small depression; the anterior margin is armed with a stout antennal and a distinct pterygostomian spine, though the latter is sometimes wanting. Back of the cervical suture the dorsum is very broad and evenly rounded, but there is often a very small dentiform tubercle in the middle line on the posterior part of the cardiac region; the rostrum in the smaller specimens is often not half as long as the carapax proper, but in the larger specimens much longer, frequently fully as long as the rest of the carapax, nearly straight and horizontal, or curved considerably upward, narrow, with a strong ridge either side, tapering to a more or less acute tip, and with the dorsal carina extending back upon the carapax nearly to the cervical suture and armed with twenty to thirty spines which are directed forward, movably articulated with the carapax, thickly crowded posteriorly but more and more remote anteriorly, and of which five to ten are crowded upon the carapax in about half the space between the orbit and the cervical suture; beneath, the rostrum is ciliated and in most of the specimens entirely unarmed, but occasionally there are one or two teeth near the tip.

The eye-stalks are short and terminated by small hemispherical black eyes. The peduncle of the antennula is about half as long as the antennal scale; the first segment is about as long as the two others taken together, excavated above for the reception of the eye, which, however, does not reach the extremity of the segment, with a prominent lateral process terminating in an acute spine, and the body of the segment itself produced in a spiniform process outside the articulation with the second segment; the second and third segments are subequal in length and nearly cylindrical. The flagella are approximately equal in length and often at least twice as long as the length from the tip of the rostrum to the tip of the telson; the upper is slightly compressed near the base, and, in the male, clothed for a short distance along the lower edge with short hairs, but otherwise like the upper. The antennal scale is thick and strong, about two-thirds as long as the carapax excluding the rostrum, about a fourth as broad as long, and only slightly narrowed toward the tip, which is truncated and does not extend beyond the strong tooth in which the thickened outer margin terminates. The flagellum is subcylindrical, and often more than three times as long as the length from the tip of the rostrum to the tip of the telson.

The second gnathopods reach beyond the middle of the antennal scales: the proximal segment is nearly as long as the two distal, vertically compressed, with a knife-like mesial edge; the middle segment

is very slender, cylindrical, and nearly naked, the distal segment is about two-thirds as long as the middle, somewhat triquetral, very slightly expanded near the middle, tapered to a point distally, and armed with numerous short setæ. The exopod is very slender and about three-fourths as long as the proximal segment of the endopod. The epipod is rudimentary, scarcely longer than the breadth of the protopod, in a transverse sulcus on the outer side of which it lies.

The first four pairs of peræopods have exopods and epipods, like the second gnathopods, but the exopods diminish in size very rapidly posteriorly and are minute upon the fourth pair. The first pair are nearly as long as the carapax, including the rostrum, and reach to about the tips of the antennal scales: the ischium is slightly longer than the merus, and both are very slender and armed with a few small spines; the carpus is very much more slender than the merus, and about twice as long, slightly enlarged at the distal extremity, and entirely naked and unarmed; the chela is about a fourth or fifth as long as the carpus, considerably stouter, slightly flattened, and the digits nearly a third of the entire length, slightly curved, and rather sparsely clothed with slender setæ. The second are similar to the first, but very much longer and more slender: the chela is about as long as in the first pair, but not quite as stout, while the ischium, merus, and carpus are very much longer than in the first pair. The third, fourth, and fifth pairs are nearly alike, much longer than the second, and exceedingly slender: the iscia, meri, and carpi are proportionally about as long as in the second; the propodi are very short, approximately a tenth as long as the carpi, and slightly stouter; the dactyli in the third and fourth pairs are a little longer than the propodi, slender, acute, and surrounded at base and almost hidden by a circle of very long and slender setæ; in the fifth pair the dactylus is very short, about a fourth as long as the propodus, but surrounded and hidden by a circle of setæ about as long as in the third and fourth.

The first and second somites of the pleon are broadly rounded above, and not at all compressed, but the succeeding somites are considerably compressed particularly near the dorsum, which is not really carinated on any of the somites however, though the third somite is prolonged in a broad and prominent tooth over the fourth. The first pleuron is broad and evenly rounded below, the second much longer than high and elliptical, the third and fourth with the posterior edges rounded, but the fifth produced posteriorly in an acute point. The sixth somite is about twice as long as the fifth, less than half as high as long, and very strongly compressed.

The telson is about as long as the sixth somite, narrow distally, rounded above, and armed with five to ten pairs of dorsal aculei and two pairs of long spines at the tip. The outer lamella of the uropod reaches to about the tip of the telson, is nearly four times as long as broad, with the rounded tip extending much beyond the tooth, in which the stout outer margin terminates, and just within which there is a spine,

as in most species of *Pandalus*. The inner lamella is considerably shorter and much narrower than the outer, and lanceolate in outline.

In the female, the inner ramus of the pleopod is lamellar, about two-thirds as long as the outer, four times as long as broad, and tapered to an acute point. In the male, this ramus is lamelliform, but shorter and very much broader, being ovate and about twice as long as broad. The inner of the two stylets on the inner ramus of the second pleopod of the male is as long as the other stylet and expanded into broad lamella obtusely rounded and ciliated at the tip.

The surface of the carapax and pleon is naked but minutely punctate.

Three specimens give the following measurements in millimeters:

Station	2035	2036	2035
Sex	♀	♂	♀
Length from tip of rostrum to tip of telson	110	110	130
Length of carapax, including rostrum	44.8	43	50.5
Length of rostrum	20.5	18.4	23.4
Hight of carapax	12	11.5	13
Breadth of carapax	12	11.8	13.3
Length of eye-stalk and eye	3.3	......	......
Greatest diameter of eye	2.8	......	......
Length of antennal scale	17.1	17.3	19
Breadth of antennal scale	4.1	4.3	4.8
Length of first peræopod	39	41	44
Length of merus	8.1	9	9.7
Length of carpus	15	16.5	17.5
Length of chela	4.1	4	4.3
Length of dactylus	1.2	1.3	1.3
Length of second peræopod	64	67	80
Length of merus	16	17	19.5
Length of carpus	23	24.5	30.5
Length of chela	4.2	4	4.5
Length of dactylus	1.2	1.1	1.6
Length of third peræopod	83	81	......
Length of merus	23	22.5	......
Length of carpus	30	28	......
Length of propodus	3.1	3	......
Length of dactylus	4.2	4	......
Length of fourth peræopod	78	......	94
Length of merus	22.8	......	27
Length of carpus	29	......	45
Length of propodus	3.2	......	3.8
Length of dactylus	4	......	4.8
Length of fifth peræopod	82	80	95
Length of merus	24	25	30
Length of carpus	35	34	41
Length of propodus	2.7	2.6	2.7
Length of dactylus	0.7	0.8	1.8
Length of sixth somite of pleon	15.2	15	17
Hight of sixth somite of pleon	7	6.7	7.5
Length of telson	14+	15.5	17.5
Length of inner lamella of uropod	12	......	......
Breadth of inner lamella of uropod	2.7	......	......
Length of outer lamella of uropod	13.6	......	......
Breadth of outer lamella of uropod	3.2	......	......

Seven other specimens give the following measurements of the body and antennal scales:

Station	2035	2037	2037	2035	2096	2036	2037
Sex	♀	♀	♀	♀	♀	♂	......
Length from tip of rostrum to tip of telson	108	129	145	135	135 +	114	130
Length of carapax including rostrum	42.5	52.2	61.5	55.0	61.4	43.7	51.0
Length of rostrum	19.0	23.7	31.0	25.0	31.6	18.1	23.5
Breadth of carapax	10.8	14.4	14.5	14.0	14.5	12.5	13.8
Length of antennal scale	16.4	20.0	23.8	20.4	21.0	19.2	19.0
Breadth of antennal scale	4.0	5.1	5.2	5.2	5.1	4.4	4.9
Length of sixth somite of pleon	15.0	17.8	19.0	18.2	18.0	15.3	17.0
Hight of sixth somite of pleon	6.8	7.8	8.0	7.9	8.0	6.9	7.3
Length of telson	15.0	19.0	20.5	18.3	......	16.0	18.0

EPHYRINÆ.

ACANTHEPHYRA A. M.-Edwards.

The figures of *Acanthephyra armata*, which Milne-Edwards has recently published (Recueil de figures de Crustacés nouveaux on peu connus), show that it is congeneric with my *Miersia Agassizii*. Milne-Edwards's genus was characterized in a very indefinite manner, one of the original species has since been referred to *Pandalus*, and no characters have been given for distinguishing it from *Miersia;* but as Milne-Edwards probably had access to typical species of *Miersia*, *Acanthephyra* is most likely a distinct genus, which should include the two following species.

In both these species the structure, number, and arrangement of the branchiæ is essentially as in the typical species of *Pandalus*, except there is no epipod at the base of the fourth leg, so that the branchial formula is as follows:

Somites.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	Total.
Epipods	1	1	1	1	1	1	0	0	(6)
Podobranchiæ	0	1	0	0	0	0	0	0	1
Arthrobranchiæ	0	0	2	1	1	1	1	0	6
Pleurobranchiæ	0	0	0	1	1	1	1	1	5
									12+(6)

ACANTHEPHYRA AGASSIZII.

Miersia Agassizii Smith, Bull. Mus. Comp. Zool., x, p. 67, pl. 11, figs. 5–7; pl. 12, figs. 1–4, 1882.

(Plate VIII, Fig. 1.)

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens— ♂	Specimens— ♀	Specimens— With eggs.
		° ′ ″	° ′ ″	*Fath.*					
5547	2002	37 20 42	74 17 36	641	gn. M.	Mar. 23	3	2	0
5530	2003	37 16 30	74 20 36	640	gn. M.	Mar. 23	3		......
5554	2030	39 29 45	71 43 00	588	bu. M.	May. 26	2		......
7083	2034	39 27 10	69 56 20	1,346	41°; glb. O.	July 17	2	1	1
7084	2037	38 53 00	69 23 30	1,731	38°; glb. O.	July 18	1	3	0
....	2040	39 35 13	68 16 00	2,226	glb. O.	July 29	1		......
7085	2041	30 22 50	68 25 00	1,608	38°; glb. O.	July 30	1		......
....	2042	39 33 00	68 26 45	1,555	38½°; glb. O.	July 30		1	0
....	2043	39 49 00	68 28 30	1,467	38½°; glb. O.	July 30	1		......
7086	2047	40 02 30	68 49 40	389	52°; bu. m.	July 31	1	1	0
7087	2051	39 41 00	69 20 20	1,106	39°; bu. M. glb. O.	Aug. 1	2		......
....	2052	39 40 05	69 21 25	1,098	45°; glb. O.	Aug. 1	1	1	1
....	2053	42 02 00	68 27 00	105	bu. M.	Aug. 29	2	1*y*. 1	0
7088	2072	41 53 00	65 35 00	858	39°; gy. M.	Sept. 2	4	1*y*. 1	1
7098	2075	41 40 30	65 35 00	855	39°; fne. S. M.	Sept. 3		1*y*.	......
7089	2077	41 09 40	66 02 00	1,255	39°; bu. M.	Sept. 4	3		......
7090	2083	40 26 40	67 05 15	959	40°; gy. M.	Sept. 5	1	1	0
7026	2094	39 44 30	71 04 00	1,022	38½°; F. M.	Sept. 21	1	1*y*. 2	1
5469	2095	39 29 00	70 58 40	1,342	glb. O.	Sept. 30		1	0
5454	2098	37 40 30	70 37 30	2,221	glb. O.	Oct. 1	1*l*.	3*l*.	3
5452	2099	37 12 20	69 39 00	2,949	glb. O.	Oct. 2	1*l*.	2*l*.	2
5462	2099	37 12 20	69 39 00	2,949	glb. O.	Oct. 2	1		......
5465	2100	39 22 00	68 34 30	1,628	37½°; glb. O.	Oct. 3	1*s*.	1	0
5640	2102	38 44 00	72 38 00	1,209	39°; glb. O.	Nov. 5	1	1	1
7134	2103	38 47 20	72 37 00	1,091	39°; glb. O.	Nov. 5		1	1
5683	2106	37 41 20	73 03 20	1,497	42½°; glb. O.	Nov. 6	1		......
5643	2110	35 12 10	74 37 15	516	40°; bu. M.	Nov. 9	2		......
5685	2116	35 45 23	74 31 25	888	39°; bu. M.	Nov. 11	1		......

The carapax in front is broader than high, but much higher than broad posteriorly, and slightly compressed above, so as to make the dorsum somewhat obtusely angular, though rounded and not at all carinate, even anteriorly. The rostrum is usually a little shorter than the rest of the carapax in large specimens, but in small specimens is often nearly or quite twice as long; it is stout at base, but rapidly tapered above the first segment of the peduncle of the antennula, beyond which it is very slender, slightly upturned, and armed with six to ten teeth above and four to seven beneath, the dorsal teeth extending back as far as the orbit, and both series reaching nearly to the acute tip. The anterior margin projects in an acute, but scarcely spiniform, angle above the base of the antenna, and opposite the base in an acute and laterally prominent branchiostegial spine, below which the branchiostegite is suddenly incurved in the anterior part of the carapax. The surface of the carapax and abdomen is naked and smooth to the unaided eye, but is microscopically punctate.

The eye-stalks are very short, and terminated by small hemispherical black eyes. The peduncle of the antennula is short, much less than half as long as the antennal scale; the first segment is fully as long as the second and third taken together, is deeply excavated above, for the reception of the eye, and its outer edge is armed distally with a small tooth; the second and third segments are broader than long and subcylindrical. The outer or major flagellum in the male is twice to three times as long as the antennal scale, with the proximal portion to near the tip of the antennal scale, compressed vertically, broadly expanded, and thickly clothed beneath with fine hairs, but the distal portion very slender and somewhat compressed vertically. In the female the compressed and thickened proximal part is much shorter and slightly narrower and the whole flagellum a little shorter. The inferior flagellum is about as long as the upper, and slender throughout. The antennal scale is approximately three-fourths as long as the carapax, excluding the rostrum, and near the base about a fourth as broad as long, but narrowed regularly to a very slender tip. The second segment of the peduncle is armed with an acute dentiform spine below, and a triangular tooth above the base of the scale. The distal segment of the peduncle reaches only about a third of the way from the base to the tip of the antennal scale. The flagellum is slender, slightly compressed, and nearly as long as the body of the animal.

The labrum is fleshy, prominent, as seen in front, and the inferior edge is thickened and slightly indurated and applied to the concave dorsal surfaces of the mandibles. The lobes of the metastome are very broad distally and somewhat truncated. The mandibles are expanded into thin, dorsally concave, and strongly dentate ventral processes, above and closely connected with which are small and narrow molar areas. The opposing edges of the ventral processes differ somewhat on the two sides: on the right side the mesial edge is slightly convex, as seen

from above or below, and armed with about eight acutely triangular teeth, beyond which there are several small teeth on the anterior edge; on the left side the mesial edge, as seen from above or below, is straight or slightly concave, terminates anteriorly in a sharp angle, beyond which there are no teeth on the anterior edge, and the teeth on the anterior part of the mesial edge are very small, though back of these small teeth there are about as many and as large teeth as on the mesial edge of the right mandible. The protognathal lobes of the first maxilla are approximately equal in size, broad at the ends, and armed as usual with slender spines upon the distal, and numerous setæ upon the proximal lobe. The endognath is small, obtusely pointed, and armed with a very few marginal setæ and with two slender spines upon a small fold on the ventral side near the tip. The protagnathal lobes of the second maxilla are very unequal, the proximal lobe is broad but very short, while the distal is long and deeply divided into two narrow and obtuse lobes. The endognath is unsegmented, short, and narrowed to a slender tip. The scaphognath projects anteriorly slightly beyond the endognath, and both ends are broad and evenly rounded.

The protopod of the maxilliped projects very little anteriorly, and is obscurely divided into a very small proximal and a large distal lobe. The endopod is well developed and composed of three segments, of which the proximal is very short, broader than long, the second nearly three times as long as broad, the terminal a little smaller than the second, and lanceolately pointed, and all the segments margined with setæ. The exopod is a very large lamelliform lobe, longer than the endopod, about a third as broad as long, expanded and broadly rounded in outline distally, and edged with plumose setæ, which gradually increase in size distally along the margin. The epipod is small, branchial, with the anterior and posterior parts approximately equal. The ischium in the first gnathopod is much shorter than broad, the merus between two and three times as long as broad, the carpus a little narrower than the merus and about as long as broad, the propodus bent back upon the merus, as in most Palæmonidæ, a little longer than the merus, nearly half as broad as long, and obliquely truncated along the mesial edge for the articulation of the dactylus, which is more than twice as broad as long, and armed with setæ and slender spines, as is the mesial and anterior edge of the dactylus. The exopod is nearly as long as the endopod, slender, and multiarticulate and flagelliform for more than half its length. The epipod is broad at base, somewhat triangular, and bears a large phyllobranchia. The endopod of the second gnathopod reaches a little beyond the middle of the antennal scale, and is slender and composed of three segments, of which the proximal is the longest, reaches as far forward as the antero-lateral angle of the carapax, and is strongly curved and dorsally compressed in the middle opposite the mouth; the middle and the distal segments are straight, the middle about half as long, and the distal nearly as

long as the proximal; all the segments are more or less setigerous. The exopod is slender, multiarticulate, flagelliform, and about as long as the proximal segment of the endopod. The epipod is narrow, lamellar, nearly as long as the middle segment of the endopod, and lies between the branchiæ of the ninth and tenth somites.

All the peræopods are furnished with exopods like those of the second gnathopods, and the first, second, and third pairs are furnished also with epipods like those of the second gnathopods. The first and second are slender, do not reach the tips of the second gnathopods, and are very nearly alike, but the carpus and chela are a little longer and more slender in the second than in the first. In both pairs the merus is a little longer than the ischium, and reaches to the antero-lateral angle of the carapax. In the first pair the carpus is scarcely more than half as long and about as stout as the merus, and the chela is somewhat longer and a little stouter than the carpus, and with slender, slightly compressed and nearly straight digits about a third of the whole length. In the second pair the carpus is scarcely as stout as the merus and about two-thirds as long, and the chela is scarcely stouter than the carpus, but considerably longer. In the second pair there is a slender spine on the lower edge of the distal end of the merus, but otherwise both pairs are unarmed, though sparsely clothed with soft hairs. The third and fourth pairs are nearly alike and reach to about the tips of the second gnathopods: the lower edges of the meri are spinulose, the propodi considerably longer than the carpi, and the dactyli slender, nearly straight, unarmed, and about a fourth as long as the propodi. The posterior plæopods are about as long as the third and fourth, and like them except the distal extremities, which are peculiarly modified. The propodus is slender, a little longer than in the third and fourth, clothed with a few long plumose setæ, thickly beset distally along the lower edge with serrately armed and simple setæ, and so densely clothed at the tip with long setæ as to very nearly hide the dactylus, which is very short, curved at the tip, and armed with several slender spines.

The pleon is large relatively to the cephalo-peræon, strongly compressed, and dorsally carinated except upon the first somite, the carina being most conspicuous on the third somite, where it projects posteriorly in a long and very slender tooth. The three succeeding somites each project similarly in a minute tooth. The pleura of the four anterior somites are broad and very deep, the height of the pleon at these somites being greater than that of the carapax. The first pleuron is as deep as the second, and its anterior edge is slightly concave in outline; the second is about as broad as high, and approximately orbicular; the third and fourth project posteriorly in broadly rounded lobes; the fifth projects posteriorly in an angular lobe obtusely rounded at the tip. The sixth somite is about a third longer than the fifth, and about twice as long as high.

The telson is much longer than the sixth somite, very slender toward

the tip, rounded and slightly sulcated above, armed with five to twelve pairs of stout dorsal aculei on the distal half, and with a median spine at the tip. The outer lamella of the uropod scarcely reaches, or falls much short of, the tip of the telson, is about four times as long as broad, tapers very slightly except near the tip, which is ovate and projects nearly the width of the lamella beyond the angle in which the thickened outer margin ends; the inner lamella is obtusely lanceolate, and considerably shorter and a little narrower than the outer.

The outer ramus of the first pleopod is long and slender like that of the succeeding pairs. The inner ramus in the male is developed into a broad oval lamella about a fourth as long as the outer ramus, setigerous on the middle of either edge, and the inner edge thickened and bearing a stylet armed along its inner edge as usual with minute hooks. In the female the inner ramus is no longer than in the male, and is narrow, lanceolate, and thickly setigerous.

In alcoholic specimens the eggs are about 0.45^{mm} and 0.32^{mm} in longer and shorter diameter.

Measurements of a large male are given under the next species.

ACANTHEPHYRA EXIMEA, sp. nov.

This species, which is represented in the collection by a single male (5644) is closely allied to the last, but is apparently a larger species, and is readily distinguished by the sharply carinated carapax and the much stouter base of the rostrum.

The carapax is higher in front than in the last species, and there is a sharp carina extending from the rostrum to near the posterior margin, rising into a slight crest on the cardiac region. The rostrum is shorter than the rest of the carapax, very stout and high at the base, tapered rapidly to about the middle, and from this point slender and slightly upturned. The dorsal edge is distally unarmed for about half the length, but back of this there is a series of about seven small teeth extending a little way back upon the carapax, while beneath there are four teeth on the middle and distal part.

The eyes, antennulæ, and antennæ are nearly as in the last species, except that the antennal scales are somewhat broader, and less slender at the tips. The oral appendages are essentially as in the last species, although the crowns of the mandibles are somewhat different, the teeth of the ventral edges being nearly uniform in size and confined to the mesial edge. The second gnathopods and the peræopods are proportionally a little stouter than in the last species, but appear not to differ in other respects.

The dorsum of the pereon is carinated and toothed nearly as in the last species, but the carina is slightly higher and the tooth of the third somite stouter. The pleuron of the fifth somite is proportionally longer and reaches nearly to the infero-posterior angle of the sixth somite, which, however, is considerably shorter and higher than in the last spe-

cies. The telson is imperfect at the tip, but is apparently shorter and stouter than in the last species. The lamella of the uropods are considerably broader than in the last species.

In the accompanying table measurements of this species and of a single specimen of *A. Agassizii* are given together.

Measurements in millimeters.

	A. eximia.	A. Agassizii.
Station	2111	2099
Sex	♂	♂
Length from tip of rostrum to tip of telson	135	120
Length of carapax including rostrum	48. 0	43. 0
Length of rostrum	27. 0	20. 0
Hight of carapax	21. 0	17. 0
Breadth of carapax at branchiostegial spines	16. 0	13. 6
Breadth of carapax about the middle	15. 0	12. 5
Length of eye-stalk and eye	5. 0	4. 6
Greatest diameter of eye	3. 5	3. 2
Length of antennal scale	22. 0	21. 0
Breadth of antennal scale	6. 2	5. 2
Length of second gnathopod	32. 0	25. 0
Length of first peræopod	30. 0	22. 0
Length of chela	7. 5	5. 6
Breadth of chela	1. 8	1. 2
Length of dactylus	3. 0	2. 4
Length of second peræopod	35. 0	26. 0
Length of chela	8. 0	7. 0
Breadth of chela	1. 3	1. 0
Length of dactylus	3. 2	2. 8
Length of third peræopod	....	31. 0
Length of propodus	....	7. 5
Length of dactylus	....	2. 3
Length of fourth peræopod	42. 0	30. 0
Length of propodus	10. 2	7. 5
Length of dactylus	2. 6	1. 9
Length of fifth peræopod	40. 0	31. 0
Length of propodus	13. 5	9. 5
Length of dactylus	0. 5	0. 6
Hight of second somite of pleon	24. 0	21. 0
Length of sixth somite of pleon	14. 0	13. 4
Hight of sixth somite of pleon	10. 0	8. 0
Length of telson	18. +	23. 0
Length of inner lamella of uropod	17. 3	15. 0
Breadth of inner lamella of uropod	5. 2	3. 4
Length of outer lamella of uropod	20. 2	17. 4
Breadth of outer lamella of uropod	6. 7	4. 8

The single specimen (5644) is from Station 2111, November 9, north lat. 35° 09′ 50″, west long. 74° 57′ 40″, 938 fathoms, green mud.

NOTOSTOMUS ROBUSTUS, sp. nov.

(Plate VII, Fig. 2.)

This species is closely allied to *N. gibbosus* A. Milne-Edwards, but is distinguished from it as figured in Milne-Edwards's Recueil de Figures de Crustacés, by its much larger eyes, much shorter and distally unarmed rostrum, and the strongly divergent lateral carinæ of the carapax. In the *gibbosus* the rostrum, measured from the back of the orbit, is much longer than in *robustus*, the high dorsal crest does not extend more than half the length, and the terminal portion is slender and serrate above and below to the very tip; while in *robustus* the dorsal crest extends to within a short distance of the slender and unarmed tip, back of which there are only three or four spiniform teeth on the under edge. In *ro-*

bustus the upper lateral carina begins just back of the base of the eye-stalk, and below and entirely separate from the posterior fading out of the lateral carina of the rostrum; is very sharp and prominent above the broad, depressed, and concave antenno-hepatic region, which is separated from the branchial region by an oblique branchio-hepatic carina, connecting the upper with the nearly straight, sharp, and prominent lower lateral carina. The posterior part of the upper carina, back of the branchio-hepatic, is less prominent than in front, nearly straight, and diverges very rapidly from the lower carina, while in *gibbosus* these carinæ are figured as very nearly parallel. In *robustus* there is a well-marked submarginal carina nearly the whole length of the inferior margin. Nearly the whole surface of the carapax between the carinæ is marked with minute dendriform elevations, which look somewhat like, but are apparently not, minute wrinkles due to contraction; otherwise the surface of both carapax and pleon is nearly smooth and quite naked. The eyes are well developed, nearly hemispherical, somewhat swollen, two-thirds as broad as the length of the eye and eye-stalk, conspicuously faceted, black, and face somewhat obliquely inward. In the male the proximal part of the upper flagellum of the antennula, for a distance the length of the antennal scale, is compressed, broadly expanded, and the outer inferior surface clothed with very short hairs; while in the female the same part is similarly but very much less expanded.

The peræopods, especially the three posterior pairs, are apparently considerably stouter in *robustus* than in *gibbosus*, and the ischia and meri in the three posterior pairs are all armed with small spines along the lower edge in *robustus*, while Milne-Edwards's figure shows no such spines anywhere upon the posterior pair, and none upon the ischia in the third and fourth pairs. In Milne-Edwards's figure, however, an articulation is incorrectly introduced in the merus in the fourth and fifth pairs and apparently also in the third, so these appendages are very likely incorrectly figured in other respects.

The dorsal carina of the pleon is apparently less conspicuous in *robustus* than in *gibbosus*, and the teeth in which it projects at the third, fourth, fifth, and sixth somites are much shorter. The dorsal facet of the first somite is overhung behind by a sharp lamellar projection, beneath which the posterior margin of the carapax fits when the pleon is extended, and which is continuous either side with the pleuron, which broadly overlaps the side of the carapax.

The entire integument of the animal is rather soft and membranaceous, but in the specimen figured the form is very well preserved. Soon after preservation in alcohol, and, according to the statement of Mr. Benedict, before the color had changed materially from that of life, the entire animal, except the eyes, was very intense dark crimson.

The oral appendages are essentially as in *Acanthephyra Agassizii* and the number and arrangement of the branchiæ are the same as in that species.

The genus *Notostomus* is very closely allied to *Meningodora* and it is quite possible that it will be necessary to unite them.

Measurements in millimeters.

Station	2042	2074
Sex	♂	♀
Length from tip of rostrum to tip of telson	135	150
Length of carapax including rostrum	61	65
Length of rostrum	13	16
Hight of carapax	35	36
Breadth of carapax	......	25
Length of eye-stalk and eye	......	6.6
Greatest diameter of eye	......	4.4
Length of antennal scale	21.0	20.5
Breadth of antennal scale	7.8	8.5
Length of second peræopod	42	44
Length of first peræopod	38	36
Length of chela	9.5	9.4
Length of dactylus	3.5	3.6
Length of second peræopod	46	45
Length of chela	9.4	9.3
Length of dactylus	3.2	3.2
Length of third peræopod	75	70
Length of propodus	34.5	31.5
Length of dactylus	3.5	3.6
Length of fifth peræopod	65	63
Length of propodus	25	24
Length of dactylus	0.7	0.6
Length of sixth somite of pleon	11.3	13.0
Hight of sixth somite of pleon	9.3	9.0
Length of telson	24.0	24.5

Station 2042, July 30, north lat. 39° 33′, west long. 68° 26′ 45″, 1,555 fathoms, globigerina ooze, temperature 38½°—1 male (7051). Station 2074, September 3, north lat. 41° 43′, west long. 65° 21′ 50″, 1309 fathoms, fine mud, temperature 40°—1 female (7052).

MENINGODORA MOLLIS Smith.

Bull Mus. Comp. Zool. Cambridge, x, p. 74, pl. 11, figs. 8–9, pl. 12, figs. 5–9, 1882.

One male (7051) was taken August 1 at Station 2051, N. lat. 39° 41′, W. long. 69° 20′ 20″, 1,106 fathoms, blue mud and globigerina ooze, temperature 39°.

On account of the extreme softness of the entire animal, this specimen, like the single female from which the species was first described, is in rather bad condition, but it has the peræopods complete, and enables me to supplement the original description to a considerable extent.

The dorsal carina, over and back of the base of the rostrum, is armed with about seven minute spiniform teeth. The proximal part of the upper flagellum of the antennula is much stouter than the lower, strongly compressed, and its outer inferior surface clothed with short hairs. The antennal scale is considerably more than twice as long as broad, very thin, foliaceous, slightly narrowed distally, and obliquely rounded at the tip.

The first peræopods are scarcely stouter than the second gnathopods and fall considerably short of their tips: the merus is compressed and as long as the proximal segment of the endopod of the second gnatho-

pod; the carpus is scarcely half as long as the merus, subcylindrical, and slightly enlarged distally; the chela is about twice as long as the carpus, very slightly swollen proximally, the digits nearly a third of the whole length, strongly curved at the tips, and the propodal one considerably stouter than the dactylus. The second peræopods are very slender and reach to the tips of the second gnathopods: the ischium and merus are strongly compressed, and the latter is longer than in the first pair, and reaches to the distal extremity of the proximal segment of the endopod of the second gnathopods; the carpus is slender, cylindrical, and about half as long as the merus; the chela is slightly longer than the carpus, scarcely as long as in the first pair, cylindrical, scarcely as stout as the carpus, not at all swollen, and with very slender and slightly compressed digits about one-fifth the entire length. The third and fourth pairs of peræopods are nearly alike: the ischia and meri are compressed and nearly as in the second pair, but a little longer; the carpi are a little shorter and broader than in the second pair; the propodi are about a third of the entire length, very slender, slightly compressed, flattened or grooved on all the four sides and with the angles acutely carinated; the dactyli are less than a third as long as the propodi, very slender, very slightly curved, regularly tapered, and angulated like the propodi.

The outer ramus in the first pair of pleopods is long and slender like that in the succeeding pairs, but the inner ramus is developed into a broad oval lamella as in *Acanthephyra Agassizii*, except that the stylet at the inner edge is very short, scarcely projecting beyond the tip of the lamella.

The number and arrangement of the branchiæ and epipods is the same as in *Acanthephyra Agassizii* and *eximea*. In the original description of the genus *Meningodora* I stated that there was apparently but one branchia at the base of the second gnathopod, as I was unable to find a second in the badly-preserved specimen first examined, but in the specimen here described there are two branchiæ as in the allied genera.

Measurements in millimeters.

Station	2051
Sex	♂
Length from tip of rostrum to tip of telson	65
Length of carapax, including rostrum	27
Length of rostrum	4
Hight of carapax	13
Length of eye-stalk and eye	4.1
Greatest diameter of eye	1.3
Length of antennal scale	9.6
Breadth of antennal scale	4.0
Length of second gnathopod	23.0
Length of first peræopod	23.0
Length of chela	6.4
Breadth of chela	1.3
Length of dactylus	2.0

Length of second peræopod	26.5
Length of chela	6.2
Breadth of chela	0.7
Length of dactylus	1.3
Length of third peræopod	36
Length of merus	10.8
Length of carpus	4.3
Length of propodus	11.0
Length of dactylus	3.4
Length of fourth peræopod	37
Length of propodus	12.0
Length of dactylus	3.3
Length of fifth peræopod	31
Length of propodus	10.0
Length of dactylus	0.2
Length of sixth somite of pleon	7.2
Hight of sixth somite of pleon	4.0
Length of telson	10+
Length of inner lamella of uropod	10.5
Breadth of inner lamella of uropod	2.6
Length of outer lamella of uropod	12.0
Breadth of outer lamella of uropod	3.9

PASIPHAIDÆ.

PASIPHAË PRINCEPS, sp. nov.

(Plate V, Fig. 2.)

This species, which is far larger than any of the genus heretofore known, is unfortunately represented by a single specimen (5473) only.

Female.—The dorsum of the carapax is rounded except for about a third of the length anteriorly, where it rises into a carina, terminating in a short, mucronate and obliquely upturned rostrum overhanging, but projecting scarcely as far forward as the front itself, which is prominent though rounded in outline as seen from above. The lower angle of the orbit projects in a prominent but obtuse angle, about as far as the front, and below this the anterior margin is armed with a small spine directed obliquely outward over the base of the antenna. The eye-stalks are short and stout, and bear the large swollen black eyes facing only very slightly outward. The eyes as seen in front are nearly circular, but slightly larger in the transverse diameter, which is about three-fourths the length of the eye-stalk and eye. The antennal scale is about two-fifths as long as the carapax, scarcely a third as broad as long, and the outer edge arcuate and terminating in an acutely triangular lamellar tooth. There is an acute spine on the peduncle of the antenna beneath the articulation of the scale as in *P. tarda*, with which species the antennæ, antennulæ, and oral appendages agree in all essential particulars, except the tip of the antennal scale just described.

The peræopods are very nearly as in *P. tarda*. The first pair are smooth, naked, and unarmed, except on the prehensile edges of the digits, which are about three-fourths as long as the body of the chela. The second pair are armed with a few small spines along the lower edge of

the propodus, and the lower distal angle of the carpus is produced into a sharp spine, but are otherwise nearly like the first pair, except longer and more slender, the chela being nearly a fourth longer, not so stout, and with the digits about as long as the body of the chela. The third pair are imperfect at the tips, exceedingly slender, cylindrical, and unarmed; the merus about two-thirds as long as the carapax, the carpus very short, and the propodus acicular and apparently about a fourth as long as the merus. The fourth pair are little more than half as long as the carapax. The fifth pair are nearly twice as long as the fourth, with the propodus and dactylus more than twice as long as in that pair.

The pleon, exclusive of the telson, is about one-half longer than the carapax, the four anterior somites are each higher than the carapax, and the posterior angles of their pleura are broadly rounded, while the corresponding angle of the fifth pleuron is nearly right angular but with the apex of the angle rounded. The second, third, fourth, and fifth somites are dorsally carinate, the fourth and fifth most conspicuously. The sixth somite is a little more than a third as long as the carapax, nearly two-thirds as high as long, about one-half as broad as high, compressed but scarcely carinated dorsally, and with a conspicuous, slightly curved, longitudinal, rib-like ridge either side. The telson is slightly longer than the sixth somite, about as long as the antennal scale, with a broad and shallow dorsal sulcus nearly the whole length, the tip divided by a narrow sinus about as deep as the breadth of the tip, and the edges of the sinus armed with about ten short spines each side. The inner lamella of the uropod is narrow, ovate, a little shorter than the telson, and about three and a half times as long as broad. The outer lamella is nearly a third longer than the inner, proportionately as broad, more obtuse at the tip, which is armed at the outer edge with an acutely triangular lamellar tooth.

The protopodites of the first four pairs of pleopods are composed of two nearly equal segments of which the proximal, or coxa, is not movably articulated with ventral wall of the somite and is consolidated very nearly its whole length with the adjacent pleuron, while the distal segment, or basis, is freely articulated with it and projects considerably below the pleuron. The coxæ in the fifth pair are much shorter than in the fourth, but otherwise the fifth pair are similar to the fourth, though shorter and not egg-bearing, the eggs being carried by the four anterior pairs and attached to the coxæ only. The outer ramus of the first pleopod is long and slender, as in the succeeding pairs, but the inner ramus expands into a short ovate lamella, bearing near the middle of its anterior edge a small process for mesial attachment, and with both margins below this clothed with long setæ. The structure of the pleopods is essentially the same in *P. tarda*, and the peculiarities are doubtless common to all the species of the genus, and to a considerable extent to the new genus *Parapasiphaë*, about to be described.

The eggs, which are just beginning to show the pigment of the devel-

oping eyes, are slightly elliptical in outline and about 3 by 4^{mm} in shorter and longer diameter.

The single specimen, from which the accompaying measurements were made, was taken at station 2095, September 30, north lat. 39° 29′, west long. 70° 58′ 40″, 1342 fath., globigerina ooze. At the next station, 1451 fath., the temperature was 37½°.

Measurements in millimeters.

Sex	♀
Length from tip of rostrum to tip of telson	215
Length of carapax	75
Hight of carapax	37
Breadth of carapax	21
Length of eye-stalk and eye	8.0
Greatest diameter of eye	6.0
Length of antennal scale	29
Breadth of antennal scale	8.8
Length of second gnathopod	65
Length of first peræopod	94
Length of chela	36
Breadth of chela	5.3
Length of dactylus	15.2
Length of second peræopod	114
Length of chela	44
Breadth of chela	4.3
Length of dactylus	21.8
Length of third peræopod	70+
Length of merus	50.5
Length of carpus	2.5
Length of propodus	11+
Length of fourth peræopod	39
Length of propodus	9.0
Length of dactylus	2.3
Length of fifth peræopod	70
Length of propodus	19.5
Length of dactylus	5.5
Hight of second somite of pleon	45
Length of sixth somite of pleon	26.3
Hight of sixth somite of pleon	16.3
Length of telson	28
Length of inner lamella of uropod	25
Breadth of inner lamella of uropod	7.2
Length of outer lamella of uropod	34
Breadth of outer lamella of uropod	9.5

PARAPASIPHAË, gen. nov.

In external characters, and especially in the form and structure of the peræopods, this genus is very near *Pasiphaë*, but the body is less compressed, and the rostrum, not separated from the front of the carapax, projects above or between the bases of the eye-stalks. In the three species seen the front margin of the carapax below the rostrum is unarmed and the lateral carinæ more conspicuous than in *Pasiphaë* and differently arranged. In all the species there is a sharp carina extending back from the base of the antenna to the hepatic region, where it

gives off a sharp carina, running downward and backward toward the inferior margin, and then continues on in a nearly straight line across the branchial region to near the posterior margin. The eyes are much smaller than in *Pasiphaë*, and are borne on the outer edge of the tip of a vertically flattened stalk, which is rather broader than the eye and projects in a more or less conspicuous terminal process just inside of the cornea. The antennulæ, antennæ, second gnathopods, peræopods, and appendages of the pleon are essentially as in *Pasiphaë*, but the oral appendages and the number of the branchiæ are essentially different.

The mandibles (Plate VI, Fig. 2) bear very small and slender palpi, composed of two approximately equal segments, while in other respects they are almost exactly as in *Pasiphaë*. The proximal lobe of the protognath of the first maxilla (Fig. 3) is well armed with spines and setæ, and is not very much smaller than the distal, which is much shorter along the mesial edge than in *Pasiphaë;* the endognath is well developed, projects much in front of the protognath, has the inner edge emarginate, and is armed with long setæ. The endopod of the maxilliped (Fig. 5) is nearly as in *Pasiphaë*, but the epipod is well developed, with free and approximately equal anterior and posterior lobes. The first gnathopod (Fig. 6) bears a rudimentary, probably epipodal, appendage, and the second gnathopod a rudimentary epipod, and at its base two arthrobranchiæ. Except in the characters above described, the oral appendages are essentially as in *Pasiphaë*.

In structure the branchiæ are essentially as in *Pasiphaë*, but there are six arthrobranchiæ each side instead of three, that is one each at the bases of the four anterior peræopods besides the two just mentioned, so that the branchial formula is:

Somites.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	Total.
Epipods	1	1	1	0	0	0	0	0	(3)
Podobranchiæ	0	0	0	0	0	0	0	0	0
Arthrobranchiæ	0	0	2	1	1	1	1	0	6
Pleurobranchiæ	0	0	0	1	1	1	1	1	5
									11+(3)

While in *Pasiphaë tarda* and *pinceps* the branchial formula is—

Somites.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	Total.
Epipods	0	0	0	0	0	0	0	0	(0)
Podobranchiæ	0	0	0	0	0	0	0	0	0
Arthrobranchiæ	0	0	0	1	1	1	0	0	3
Pleurobranchiæ	0	0	0	1	1	1	1	1	5
									8 + (0)

PARAPASIPHAË SULCATIFRONS, sp. nov.

(Plate V, Fig. 4; Plate VI, Figs. 1–7.)

Female.—The carapax is high back of the middle but vertically contracted in front, as in the species of *Pasiphaë*, with the dorsal carina extending the whole length and rising into a high crest in front, but the

edge of the crest is truncated and sulcated longitudinally from the middle of the gastric region to the tip of the rostrum, or for nearly a third of the entire length. The front projects straight forward in an acute rostrum about half as long as the eye-stalk. Below the small orbital sinus each side, the short anterior margin is nearly vertical to the base of the antenna, where it is at first longitudinal and then transverse, leaving a broad open space opposite the efferent branchial passage.

The eye-stalks are nearly two-fifths as long as the antennal scales, compressed vertically, about half as broad as long, and project in front, just inside the cornea, in a small conical tubercle. The eyes are approximately hemispherical, though slightly compressed vertically, distinctly faceted, and colored with pigment which is dark brown in the alcoholic specimens. The peduncle of the antennula is about three-fourths as long as the antennal scale; the proximal segment is more than half the entire length, and bears a squamiform lateral process, which is concave on its outer surface and projects at its upper edge in an acute tip reaching nearly as far forward as the body of the segment itself; the middle segment is very short, and the distal about twice as long. The inner or minor flagellum is very slender, subcylindrical, and about as long as the carapax, while the outer is compressed and expanded at the base, and much stouter than the inner. There is an inconspicuous tooth below the base of the antennal scale, but otherwise the peduncle of the antenna is unarmed. The antennal scale is narrow, ovate, about two-fifths as long as the carapax, nearly a third as broad as long, and stiffened by two longitudinal rib-like ridges on the dorsal surface, one nearly median, the other parallel with and very near the outer edge and terminating in the distal spine, which projects beyond the narrow but obtusely rounded tip. The flagellum is somewhat compressed and approximately twice as long as the carapax.

The second gnathopods (Plate VI, Fig. 7), are about as long as the carapax and reach to the tips of the antennal scales: the coxa bears a rudimentary epipod; the basis is elongated and bears an exopod reaching half way to the tip of the endopod, with the proximal segment of which it is consolidated, as in the species of *Pasiphaë*, the segment thus formed (the antepenultimate) being nearly as long as the two distal taken together, broader than they, strongly compressed in the middle, and sparsely setigerous; the two distal segments are slender and compressed, the penultimate a little more than half as long as the ultimate, and both armed on the inner side with setæ which become spiniform at the tip.

The first peræopods reach by the tips of the antennal scales about half the length of the chelæ, and are smooth, nearly naked, and unarmed, except the prehensile edges of the digits: the merus is a little shorter than the antennal scale and strongly compressed; the carpus a little longer than broad, compressed, with the distal angles sharp; the chela is longer than the antennal scale, the outer surface of the body slightly

concave and its dorsal edge strongly compressed and thin, the digits considerable shorter than the body of the chela, slender, tapering to very slender and strongly curved tips, and the prehensile edges armed, except at the tips, with a closely set uniform series of slender spiniform teeth. The second peræopods are about a third longer than the first: the basis and ischium are armed with minute spines or teeth along the lower edge; the merus is about a third longer but scarcely stouter than in the first pair, and the lower edge is armed with a series of several acute spiniform teeth; the carpus is scarcely longer than in the first pair, but the lower distal angle is produced and spiniform; the chela is about a third longer than in the first pair and much more slender, being absolutely narrower, and narrowed from near the base, the body is convex on the outside and flat on the inside, and the digits are as long as the body, with sharply curved tips, armed as in the first pair. The third peræopods are a little shorter than the first, exceedingly slender, subcylindrical, naked, and unarmed: the merus is nearly half the entire length; the carpus very short; the propodus is more than half as long as the merus, and tapers to a very slender tip which bears a short seta-like dactylus. The fourth peræopods are about as long as the meri in the third pair and very slender throughout; the merus is about a third the length of the endopod, and about equal to the propodus and dactylus taken together, while the dactylus is only about a fourth as long as the propodus. The fifth peræopods are about a third longer than the fourth and slender throughout; the merus and propodus are subequal and together make more than half the whole length, and the dactylus is less than a third as long as the propodus. The exopods of the first and second pairs are slightly longer than those of the second gnathopods, while those of the three posterior pairs decrease in length successively to the fifth pair, where they scarcely reach by the middle of the merus.

The pleon is about twice as long as the carapax, the three anterior somites are higher than the carapax, with the dorsum evenly rounded and the lower edges of their pleura horizontal and the angles rounded. The fourth somite is armed with a dorsal carina, beginning at the middle of the somite and produced back over the next somite in a small and acute tooth; the lower edge of the pleuron is on a line with those of the preceding somites, and its angles rounded or obtuse. The fifth somite is only a little higher than the sixth; the dorsum is flattened and slightly sulcated; and the pleuron is truncated below, but the apices of the angles are obtuse. The sixth somite is considerably shorter than the antennal scale, about two-thirds as high as long, compressed, and the dorsum rounded.

The telson is about one-half longer than the sixth somite, has a dorsal sulcus, but no dorsal or lateral aculei, and is regularly tapered to a narrow, convex tip, armed with six to eight slender spines, of which the lateral pair are much the larger. The inner lamella of the uropod is

nearly as long as the telson, narrow ovate, and about a third as broad as long. The outer lamella is very little longer than the inner, a little broader proportionately, and the tip broad, rounded, and projecting much beyond the small distal spine of the outer edge.

The pleopods are nearly as in *Pasiphaë princeps*, but the inner lamelliform ramus in the first pair is more elongated, with the small process of the anterior edge nearer the tip.

The eggs are very few in number, not over twenty-five in any of the specimens examined, and enormous for the size of the animal, being 4 by 5^{mm}, in shorter and longer diameter.

Measurements in millimeters.

Station	2072	2034
Sex	♀	♀
Length from tip of rostrum to tip of telson	73	83
Length of carapax including rostrum	24.2	26.0
Length of rostrum	2.0	2.1
Hight of of carapax	13	14
Breadth of carapax	8.2	9.0
Length of eye-stalk and eye	3.7	4.1
Greatest diameter of eye	1.6	1.9
Length of antennal scale	10.0	10.5
Breadth of antennal scale	3.2	3.3
Length of second gnathopod	22.5	24.0
Length of first paræopod	33	35
Length of chela	12.0	12.3
Breadth of chela	2.1	2.2
Length of dactylus	4.7	5.1
Length of second peræopod	44	48
Length of chela	18.0	20.5
Breadth of chela	2.0	2.1
Length of dactylus	9.2	10.0
Length of third paræopod	29	32+
Length of merus	13.6	16.0
Length of carpus	0.7	0.8
Length of propodus	8.0	10.2
Length of dactylus	1.2	......
Length of fourth peræopod	12	14
Length of propodus	2.4	3.5
Length of dactylus	0.6	0.8
Length of fifth peræopod	16	21
Length of propodus	4.5	5.6
Length of dactylus	1.6	2.0
Length of sixth somite of pleon	8.0	8.5
Hight of sixth somite of pleon	5.2	5.4
Length of telson	12.0	13.3
Length of inner lamella of uropod	10.5	12.8
Breadth of inner lamella of uropod	2.8	3.0
Length of outer lamella of uropod	11.5	13.0
Breadth of outer lamella of uropod	3.4	4.1

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens— ♂	Specimens— ♀	Specimens— With eggs.
		° ′ ″	° ′ ″	*Fath.*					
5551	2002	37 02 42	74 17 36	641	gn. M.	Mar. 23	1*g*.		0
7047	2034	39 27 10	69 56 20	1,346	41°; glb. O.	July 17		1	1
7046	2037	38 53 00	69 23 30	1,731	38°; glb. O.	July 18		1	1
7048	2072	41 53 00	65 35 00	858	39°; gy. M.	Sept. 2		1	......
7049	2074	41 43 00	65 21 50	1,809	40°; fne. S. M.	Sept. 3		1	......
5352	2094	39 44 30	71 04 00	1,022	38½°; F. S. M.	Sept. 30		2	2
5459	2097	37 56 20	70 57 30	1,917	glb. O.	Oct. 1	1*y*.		......
7022	2099	37 12 20	69 39 00	2,949	glb. O.	Oct. 2		1	1
5657	2105	37 50 00	73 03 50	1,395	41°; glb. O.	Nov. 6		1*s*	0
5649	2110	35 12 10	74 57 15	516	40°; bn. M.	Nov. 9		1	0

PARAPASIPHAË CRISTATA, sp. nov.

(Plate V, Fig. 3.)

Female.—This species, which is represented by a single specimen (7021), is very closely allied to the last. The dorsal crest of the carapax, however, is not truncated nor sulcated in front, but evenly arcuated longitudinally, and very sharp to the tip of the acute rostrum, which is slightly longer than in *P. sulcatifrons*. The eyes are very much smaller, their diameter being less than a third the length of the stalk, while in *P. sulcatifrons* the diameter is nearly half the length of the stalk. The eye-stalks themselves are fully as broad as in *P. sulcatifrons*, expanded at the distal end inside the eye, and terminating in a prominent, curved, and conical tubercle, which projects much in advance of the eye. The fourth somite of the pleon has a slight dorsal carina back of the middle, and the posterior margin projects dorsally over the fifth somite in a broad angular prominence, not a narrow triangular tooth as in *P. sulcatifrons*. The fifth somite is rounded above and not sulcated.

Station 2100, October 3, north lat. 39° 22′, west long. 68° 34′ 30″, 1628 fath., globigerina ooze, temperature 37½°.

Measurements in millimeters.

Sex	♀
Length from tip of rostrum to tip of telson	73
Length of carapax including rostrum	24.4
Length of rostrum	2.5
Hight of carapax	13
Breadth of carapax	8.5
Length of eye-stalk and eye	3.8
Greatest diameter of eye	1.1
Length of antennal scale	10.0
Breadth of antennal scale	3.1
Length of second gnathopod	22
Length of first peræopod	33
Length of chela	13.0
Breadth of chela	2.5
Length of dactylus	5.8
Length of second peræopod	44
Length of chela	17.5
Breadth of chela	2.0
Length of dactylus	9.6
Length of third peræopod	29+
Length of merus	14.0
Length of carpus	0.7
Length of propodus	5.2+
Length of fourth peræopod	13
Length of propodus	3.0
Length of dactylus	0.8
Length of fifth peræopod	16.5
Length of propodus	5.2
Length of dactylus	1.3
Length of sixth somite of pleon	8.2

Hight of sixth somite of pleon	4.9
Length of telson	12.0
Length of inner lamella of uropod	10.7
Breadth of inner lamella of uropod	2.5
Length of outer lamella of uropod	11.6
Breadth of outer lamella of uropod	3.3

PARAPASIPHAË COMPTA, sp. nov.

Female.—This species, like the last, represented by a single specimen, agrees essentially with the two foregoing species in the form of all the appendages and in the number and position of the branchiæ, but is at once distinguished by the form of the dorsal crest and rostrum, the non-carinated pleon, and the form and armament of the extremity of the telson.

The carapax is more compressed than in either of the other species, and on the posterior two-thirds is armed with a sharp, but not high, dorsal carina, which rises on the anterior part of the gastric region into a high and very thin crest projecting forward in a laterally thin lamellar rostrum with a broad and obtuse tip reaching considerably beyond the middle of the eye-stalks. The eyes and eye-stalks are very nearly as in *P. sulcatifrons*, except that the former are apparently black in the alcoholic specimen, and perhaps slightly more compressed vertically. The antennal scale is about three-eighths as long as the carapax, nearly four times as long as broad, and terminates in a triangular tooth instead of a spine.

The second gnathopods, though only about as long as the carapax, reach considerably by the tips of the antennal scales. The first peræopods are a little longer, and their chelæ more slender than in either of the other species: the merus is a little longer than the antennal scale, and armed with a few teeth along the lower edge; the distal angle of the upper edge of the carpus is somewhat produced and acute; and the chela is more than half as long as the carapax, nearly three-eighths longer than the antennal scale, with the digits nearly as long as the body of the chela. The second peræopods are about a sixth longer than the first; the basis, ischium, and merus are armed with a very few spines along their lower edges, and the merus is about as long as the merus and carpus in the first pair; the chela is about a fourth longer than in the first pair, and the digits about as long as the base of the chela.

None of the somites of the pleon are dorsally carinated or have the posterior margins produced. The sixth somite is scarcely three-fourths as long as the antennal scale and proportionately a little higher than in *P. sulcatifrons*. The telson is half as long as the carapax, fully three-fourths longer than the sixth somite, dorsally sulcated, tapers regularly to where it is very narrow near the tip, and then suddenly expands laterally, and terminates in an ovately rounded extremity, armed with about eighteen slender spines, of which the sublateral and median are

the larger. The inner lamella of the uropod is longer than the antennal scale, does not reach the tip of the telson, is narrow ovate, and about three and a half times as long as broad. The outer lamella is about an eighth longer than the inner, reaches considerably by the tip of the telson, is proportionately about as broad as the inner, and the tip broad, rounded, and projecting somewhat beyond the triangular lamellar tooth in which the outer margin terminates.

The specimen (7050), which is in rather bad condition on account of the softness of the integument, was taken at Station 2039, July 28, north lat. 38° 19′ 26″, west long. 68° 20′ 20″, 2,369 fathoms, globigerina ooze.

Measurements in millimeters.

Sex	♀
Length from tip of rostrum to tip of telson	120
Length of carapax, including rostrum	44
Length of rostrum	3.5
Hight of carapax	21
Breadth of carapax	13±
Length of eye-stalk and eye	5.6
Greatest diameter of eye	2.2
Length of antennal scale	16.5
Breadth of antennal scale	4.3
Length of second gnathopod	44
Length of first peræopod	59
Length of chela	23.5
Breadth of chela	3.8
Length of dactylus	11.4
Length of second peræopod	69
Length of chela	29
Breadth of chela	3.5
Length of dactylus	14.5
Length of third peræopod	42+
Length of merus	26
Length of carpus	1.2
Length of propodus	5+
Length of fourth peræopod	22
Length of propodus	3.9
Length of dactylus	2.2
Length of fifth peræopod	34
Length of propodus	9.0
Length of dactylus	2.9
Length of sixth somite of pleon	12.5
Hight of sixth somite of pleon	7
Length of telson	22
Length of inner lamella of uropod	17
Breadth of inner lamella of uropod	4.8
Length of outer lamella of uropod	19
Breadth of outer lamella of uropod	5.6

PENÆIDÆ.

BENTHŒCETES BARTLETTI, gen. nov.

Benthesicymus Bartletti Smith, Bull. Mus. Comp. Zool., x, p. 82, pl. 14, figs. 1-7, 1882.

(Plate X, Fig. 8.)

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens. ♂	Specimens. ♀	Specimens. With eggs.
		° ′ ″	° ′ ″	*Fath.*					
5555	2030	39 29 45	71 43 00	588	bu. M.	May 26	2	1	0
7116	2072	43 53 00	65 35 00	858	39°; gy. M.	Sept. 2	1		......

The second gnathopods, which were wanting in the single imperfect specimen described from the "Blake" collection, show that this species does not belong to Bate's genus *Benthesicymus*, to which it was very doubtfully referred. In *Benthesicymus* the second gnathopod is described as terminating in a "sharp-pointed dactylus," which is afterward referred to (under *Gennadas*) as "cylindrical and sharp," while in our species the dactylus of the second gnathopod is short and flattened, and truncated at the tip—differences undoubtedly accompanied by other differences in the oral appendages, which are not described in Bate's species. The genus here proposed is further characterized by the structure of the maxillipeds and first gnathopods, and apparently also by the form of the dactyli of the fourth and fifth peræopods. The number and arrangement of the branchiæ, as shown in the following table, is apparently the same as in Bate's genus. All the podobranchiæ, except the posterior one on each side are, however, much more slender than the corresponding arthro- and podobranchiæ, and the highest and most anterior of the two branchiæ at the base of the second gnathopod arises in the border of the articular membrane, corresponds very nearly in size and position with the podobranchiæ of the somites back of it, and might, perhaps, more properly be considered a pleurobranchia than an arthrobranchia, as it is in the following table. There is the same difficulty in distinguishing between pleuro- and arthrobranchiæ in many other genera.

Somites.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	Total.
Epipods	1	1	1	1	1	1	1	0	(7)
Podobranchiæ	0	1	1	1	1	1	0	0	5
Arthrobranchiæ	1	2	2	2	2	2	2	0	13
Pleurobranchiæ	0	0	1	1	1	1	1	1	6
									24+(7)

The specimens from the Albatross collection enable me to correct somewhat the original description of the species, and I therefore restate the more essential characteristics.

Male.—The carapax is scarcely at all compressed laterally, and the dorsal carina of the anterior half rises suddenly just back of the orbit into a lamellar crest, which projects forward in a short, acute, and, as seen from the side, triangular rostrum, reaching about three-fourths of the way from the base to the tip of the eye-stalk, and armed above with two sharp teeth, one at the highest point just over the orbit, and the other nearly half way from it to the tip.

The eye-stalks are about a third as long as the antennal scales, slender, strongly compressed vertically, with a small obtuse dentiform prominence at the middle of the inner side, and just in front and outside of this a small spot of black pigment, showing faintly on the upper, but conspicuously on the lower side. The eyes themselves are scarcely wider than the stalks, but are less compressed vertically, though still much broader than high, distinctly faceted, and dark brown in the alcoholic specimens.

The flagella of the antennulæ are imperfect in all the specimens, but both flagella are longer than the antennal scale, and the proximal part of the upper is considerably stouter than the lower.

The antennal scale is about two-thirds as long as the carapax along the dorsal line, about a third as broad as long, and only slightly narrowed at the sharp tooth terminating the thickened outer margin, beyond which the anterior margin is oblique, so that the tip is toward the inner edge, and much in front of the terminal tooth of the outer margin.

The mandibles are almost exactly alike, somewhat contracted at the crowns, which are small, and nearly as in *Penæus*. The proximal of the two segments of the palpus is considerably the longer and broader, while the distal is narrowly ovate, with the tip rounded.

The proximal lobe of the protognath of the first maxilla is small and ovate, the distal lobe obliquely truncated and armed as in the allied genera. The endognath is narrow, curved, unsegmented, and shorter than the distal lobe of the protognath.

The three distal lobes of the protognath of the second maxilla increase successively in size distally, the distal being twice as wide as the next. The endognath is much shorter than the distal lobe of the protognath, and tapers regularly to the tip. The anterior part of the scaphognath is much longer than the posterior and projects beyond the protognath, while the posterior part is short, broadly expanded, and strongly incurved at the extremity.

The protopod of the maxilliped projects anteriorly in a straight lobe twice and a half as long as broad and rounded at the tip. The endopod is composed of three very distinct segments: a narrow basal one reaching a little by the protopod and with a slight expansion of the inner edge armed with slender spines, while the rest of the inner margin and the distal part of the outer are clothed with hairs; a second segment about half as long as the first, but expanded in the middle so as to be somewhat elliptical and nearly half as broad as long, with very long

plumose setæ on the outer edge and smaller and more numerous ones on the inner; and a small terminal segment about a third as long as the second, half as broad as long, and edged with small setæ or hairs. The exopod is longer even than the endopod, the proximal two-thirds or three-fourths of its length wider than the first segment of the endopod, but the distal portion narrowed, multiarticulate, and flagelliform. The lamelliform branchial epipod is as large as the endopod and the anterior portion a little smaller than the posterior.

The ischium of the first gnathopod is broader than long: the merus fully as long as the three distal segments taken together, more than three times as long as broad, compressed along the mesial edge, but not expanded distally, and very little wider than the ischium and propodus; the carpus and propodus are subequal in length and each a little longer than wide; the dactylus is a little shorter than the propodus, only half as wide as long, and narrowed to a somewhat triangular tip, which is armed with two or three curved spines; the edges of all the segments are more or less hairy or setigerous. The exopod is slender, regularly tapered, about a half longer than the endopod, and its distal half multiarticulate, flagelliform, and furnished with long plumose setæ, while the proximal part is unsegmented and furnished with short hairs or setæ. The epipod is short, nearly orbicular, and bears a short and dense dendrobranchia.

The second gnathopod (Plate X, Fig. 8) reaches considerably by the middle of the antennal scale: the ischium is nearly a third of the entire length of the endopod and strongly compressed; the merus is about two-thirds as long as the ischium, compressed proximally, but narrowed slightly toward the distal end, which is approximately cylindrical; the carpus is slender, and about as long as the merus; the propodus is slightly smaller and shorter than the carpus, but otherwise like it; the dactylus is turned in toward the mesial line and carried at right angles to the propodus, is about a third as long as the propodus, very little narrowed, and not tapered, but compressed and truncated at the tip, the edge of which is chitinous, and armed with a few stout spines, and the chitinous edge continued along the outer edge, which is armed with short spinules and setæ; the inner edges of all the segments except the dactylus are armed with long setæ. The exopod is like that of the first gnathopod except that it is a little smaller. The epipod is about as long as in the first gnathopod, but narrow, ovate, and bears a dendrobranchia nearly as long as itself.

The first peræopods are slender and reach scarcely by the bases of the antennal scales: the merus is slightly longer than the ischium, and both these segments are strongly compressed vertically and setigerous along the inner edges; the carpus is slightly compressed, about as wide as the merus, and setigerous like it; the chela is about as long as the carpus, and no stouter, and the digits are about as long as the basal por-

tion, slender, very slightly curved at the tips, and the prehensile edges setigerous.

The second peræopods are much like the first, but a little more slender and considerably longer, reaching to the tips of the peduncles of the antennæ; the merus and carpus are approximately equal in length, and narrower than in the first pair, and the chela is considerably shorter than the carpus.

The third peræopods reach beyond the middle of the antennal scales, are more slender than the second pair, and naked except at the tips of the digits: the ischium is shorter than the merus, and both these segments are very narrow and slightly compressed; the carpus is about as long as the merus, or a little longer, and subcylindrical; the chela is about half as long as the carpus, very slender, scarcely stouter than the carpus, and the digits slightly more than half the whole length.

The endopods of the fourth peræopods are wanting or imperfect in all the specimens. They are very slender, and, exclusive of the dactyli, considerably longer than the third pair: the ischium and merus are slightly compressed and setigerous along the inner edges; the carpus is a little shorter than the merus, and both the carpus and propodus are throughout cylindrical, exceedingly slender; much more slender than the distal end of the merus, and naked.

The fifth peræopods are wanting in all but one specimen, and in this only one of them is complete. This peræopod is like the fourth pair, but even more slender, and about as long as those of the third pair: the carpus and propodus are subequal in length and each is a little shorter than the merus; the dactylus is a little shorter than the propodus, very slender, cylindrical, rather suddenly tapered at the tip, which is armed with a few setæ, and is not hard and chitinous, but apparently somewhat soft and flexible.

There are no exopods at the bases of any of peræopods.

The pleon is slightly more than twice as long as the carapax, anteriorly about as broad as high, but much compressed posteriorly, so that the sixth somite is fully twice as high as broad. The dorsum is evenly rounded on the first four somites, but there is a narrow and sharp carina on the fifth and sixth, which upon the middle of the fifth is armed with a very slender spiniform tooth projecting back as far as the posterior edge of the somite. This tooth is broken in nearly all of the specimens, and in the specimen from the Blake dredgings was wholly wanting, having undoubtedly been broken off close to the base. The posterior prolongations of the first and second pleura are broadly rounded; those of the third and fourth less broad and more angular, but still obtuse and rounded at the posterior angle; while the fifth is acutely angular, but with the tip itself obtuse. The sixth somite is twice as long as the fifth, and more than half as high as long.

The telson is shorter than the sixth somite, narrowly triangular,

thickened and transversely very strongly convex above at base, but not carinated, and posteriorly flattened or even slightly sulcated above. The extreme tip is acute and spiniform, and the edges are clothed with slender setæ.

The lamellæ of the uropods are thin and lanceolate in outline. The inner is only a little shorter than the sixth somite, less than a third as broad as long, and stiffened in the middle by two slender rib-like thickenings, separated, on the dorsal surface, by a narrow sulcus. The outer is about a half longer than the inner, about a fourth as broad as long, and the narrow tip is prolonged far beyond the sharp spine in which the thickened outer margin terminates, and from which a slender rib-like thickening, with a narrow sulcus along its inner edge on the dorsal surface, runs nearly parallel with the outer edge to the base of the lamella.

The sternum of the first somite of the pleon is armed with a large median laterally compressed dentiform process, which projects forward in an acute point. The first pleopods are as large as the second, much longer than the uropods, and the distal multiarticulate portion is more than three times as long as the protopod and very slender. The peculiar male appendage (petasma) is a thin, squarish plate attached by a constricted base, below which there is a small oblong process standing out at nearly right angles to the plane of the rest of the plate. The plate itself, which is apparently carried in a nearly horizontal position, in front and on the mesial side of the protopod to which it is attached, is obliquely divided vertically or longitudinally by imperfect articulations into three parts, of which the middle one is much the largest and projects at the inner inferior angle in a large ovately-pointed process, while the inner or distal of the three parts is narrow and has the lower or posterior part of its free edge armed with minute hooked spines for the attachment of the appendages of the opposite sides of the animal. The outer rami of the second to the fifth pairs of pleopods are similar to the single rami of the first pair. The inner ramus in the second pair is very much more slender and considerably shorter than the outer, and is furnished on the anterior side at base with two small and obtusely terminated, hard, lamelliform processes. The inner rami of the third, fourth, and fifth pairs are as in the first pair except that they are without the lamelliform processes at base.

The single *female* examined wants the endopods of the fourth and fifth peræopods, except a part of one of the fourth pair, and is very nearly like the males. The bases of the upper flagella of the antennulæ are perhaps a little more slender than in the males; the male appendage of the first pleopod is replaced by a minute styliform process; and in place of the two plates at the distal end of the protopod of the second pleopod, there is a single and much shorter plate.

Measurements in millimeters.

Station	2030	2072	2030
Sex	♂	♂	♀
Length from tip of rostrum to tip of telson	77	88	76
Length of carapax including rostrum	24.3	27.5	24.5
Length of rostrum	4.1	4.0	4.3
Hight of carapax	12.5	......	13.0
Breadth of carapax	12.2	......	12.0
Length of eye-stalk and eye	6.0	6.0	6.1
Greatest diameter of eye	2.0	2.5	2.2
Length of antennal scale	16.0	19.0	15.6
Breadth of antennal scale	5.4	6.0	5.2
Length of second gnathopod	22.5	26.0	22.0
Length of propodus	3.7	4.5	3.6
Length of dactylus	1.3	1.5	1.2
Length of first peræopod	15	19.0	16.0
Length of merus	4.1	5.5	4.5
Length of carpus	3.4	3.5	3.4
Length of chela	3.0	3.6	3.5
Breadth of chela	0.7	1.0	0.8
Length of dactylus	1.4	1.7	1.5
Length of second peræopod	21.0	26.0	20.0
Length of merus	6.1	7.3	6.0
Length of carpus	5.6	6.0	5.5
Length of chela	4.0	4.6	3.8
Breadth of chela	0.8	1.0	0.7
Length of dactylus	2.1	2.5	2.0
Length of third peræopod	27.0	33.0	28.0
Length of merus	8.0	9.0	8.4
Length of carpus	8.4	10.2	8.3
Length of chela	4.5	5.4	4.5
Breadth of chela	0.7	0.8	0.6
Length of dactylus	2.3	2.9	2.3
Length of fourth peræopod	35+	......	31+
Length of merus	11.8	......	10.7
Length of carpus	9.5	......	9.0
Length of propodus	11+	......	7+
Length of fifth peræopod	27.0	......	......
Length of merus	7.0	......	......
Length of carpus	5.2	......	......
Length of propodus	5.1	......	......
Length of dactylus	4.0	......	......
Length of pleon	53.	60	52
Length of sixth somite of pleon	12.7	13.5	11.9
Hight of sixth somite of pleon	7.5	8.5	7.6
Length of telson	10.9	11.8	10.2
Length of inner lamella of uropod	10.5	12.3	10.0
Breadth of inner lamella of uropod	3.0	3.8	3.0
Length of outer lamella of uropod	16.3	18.0	15.3
Breadth of outer lamella of uropod	4.1	4.7	3.7

A. Milne-Edwards's "*Benthesicymus Bartletti* (Smith)?" from the Travailleur dredgings (figured in the Recueil de Figures de Crustacés nouveaux ou peu connus, April, 1883), if correctly figured, is certainly specifically different from my species, and probably belongs to a different genus, perhaps to Bate's *Benthesicymus.* In Milne-Edwards's species, the dactylus of the second gnathopod is figured as slender and styliform, and the dactyli of the fourth and fifth peræopods are represented as very long, slender, multiarticulate, and flagelliform. It is possible that the single dactylus of a fifth peræopod of *Benthœcetes Bartletti* which I have been able to examine may be a reproduced and abnormal segment, and that the fourth and fifth peræopods are similar to those in Milne-Edwards's species, but I think this not at all probable.

BENTHESICYMUS? CARINATUS, sp. nov.

(Plate X, Figs. 6, 7.)

A single mutilated female (7027) from Station 2094, September 21, north lat. 39° 44′ 30″, west long. 71° 4′, 1,022 fathoms, foraminifera, sand

and mud, temperature 38½°, represents a species closely allied to the last though generically distinct from it, and perhaps belonging to Bate's genus, as indicated above. The generic affinities of this species are so interesting that I describe it, although the specimen is in bad condition and wants the endopods of the second gnathopods and of all the peræopods.

The form and areolation of the carapax are nearly as in the last species, but the crest upon the rostrum is higher and apparently unarmed. The eyes, antennulæ, and antennæ are apparently nearly as in the last species, though the badly mutilated antennal scales appear to be broader and the anterior margin ovate and not oblique. The mandibles and maxillæ are essentially as in the last species, although the distal lobe of the protognath of the second maxilla is proportionately broader. The maxilliped also agrees very closely with that of the last species, except the penultimate segment of the endopod (Plate 10, Fig. 6) is a little broader distally and the ultimate segment very short, scarcely a tenth as long as the penultimate, and broader than long.

The endopod of the first gnathopod (Fig. 7) is almost exactly as in *Amalopenæus elegans*, the merus being expanded into a broad lamellar plate, half as broad as long, and projecting distally in a thin and broadly rounded lobe beyond the articulation of the carpus, so that when the three short distal segments are flexed they are concealed by it.

The number and arrangement of the branchiæ and epipods are exactly as in the last species, but there are small rudimentary exopods at the bases of all the peræopods.

The pleon is very nearly as in the last species in general form, but there is a crest-like dorsal carina on the third and fourth somites, and a sharp carina on the fifth and sixth. The telson is about as long as the sixth somite, of nearly the same form as in the last species, but more distinctly sulcated above and armed at the tip with a short median spiniform tooth and a spine either side at its base, and just above the tip with two or three spines along each side. The pleopods are nearly as in the female of the last species, but there is no conspicuous process on the sternum of the first somite.

Measurements in millimeters.

Length from tip of rostrum to tip of telson	74
Length of carapax including rostrum	28
Length of rostrum	5.0
Length of antennal scale	14.7
Breadth of antennal scale	5.8
Length of sixth somite of pleon	11.0
Hight of sixth somite of pleon	5.4
Length of telson	11.0

BENTHESICYMUS ? sp. indet.

(Plate X, Figs. 3, 4, 5.)

A single mutilated specimen (7117), wanting the whole of the pleon and the endopods of the fourth and fifth peræopods represents still an-

other species, which has very interesting affinities to the species just described. This specimen is from Station 2042, July 30, north lat. 39° 33′, west long. 68° 26′ 45″, 1,555 fathoms, globigerina ooze, temperature 38½°.

The carapax is broken and badly distorted, but is evidently very nearly like that of *Benthœcetes Bartletti*, and the rostrum is similar in form and is armed with two teeth in the same way. The eyes, antennulæ, antennæ, mandibles, and maxillæ are essentially as in *Benthœcetes Bartletti*. The ultimate segment of the endopod of the maxilliped (Plate X, Fig. 3) is about a sixth as long as the penultimate segment and intermediate in form and size between that of *Benthœcetes Bartletti* and that of *Benthesicymus ? carinatus*, and the distal extremity of the exopod is suddenly narrowed into a slender flagellum, but otherwise the maxilliped agrees with that of *Benthœcetes Bartletti*.

The first gnathopod (Fig. 4) is intermediate in form between that of *Benthœcetes Bartletti* and that of *Benthesicymus ? carinatus* : the mesial side of the merus is expanded into a thin lamella the whole length of the segment, which is two-fifths as broad as long but not much broader distally than proximally and projects only very slightly beyond the articulation of the carpus; the terminal segments are nearly as in *Benthesicymus ? carinatus*. The second gnathopods (Fig. 5) reach beyond the middle of the antennal scales, and the relative proportion of the segments is about the same as in *Benthœcetes Bartletti*, but the form of the dactylus is different, though it is carried in the same position. This segment is a little longer and narrower than in *Benthœcetes Bartletti*, and obliquely truncated on the mesial side at the extremity, so that the triangular tip, which is armed with a single long spine, is at the outer edge; the outer and the truncated distal edges are setigerous.

There are minute rudimentary exopods at the bases of all the peræopods, of which the first three pairs are otherwise very much as in *Benthœcetes Bartletti*, except that they are much longer and more slender, the second pair reaching beyond the middle of the antennal scales and the third pair far beyond the tips.

The number and arrangement of the branchiæ and epipods is apparently the same as in *Benthœcetes Bartletti*.

The specimen gives the following, merely approximate, measurements in millimeters:

Length of carapax	21
Length of second gnathopod	22
Length of first peræopod	19
Length of second peræopod	28
Length of third peræopod	42

AMALOPENÆUS ELEGANS Smith.

Bull. Mus. Comp. Zool., x, p. 87, pl. 14, figs. 8–14, pl. 15, figs. 1–5, 1882.

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens. ♂	Specimens. ♀
		° ′ ″	° ′ ″	*Fath.*				
5548	2002	37 20 42	74 17 36	641	gn. M.	Mar. 23	3	8
7120	2003	37 16 30	74 20 36	640	gn. M.	Mar. 23		1
7108	2035	39 26 12	70 02 37	1,362	38°; glb. O.	July 17		1
7109	2036	38 52 40	69 24 40	1,735	38°; glb. O.	July 18	1	
7110	2039	38 19 26	68 20 20	2,369	glb. O.	July 28		2
7111	2040	38 35 13	68 16 00	2,226	glb. O.	Aug. 1	Fragment.	
7112	2076	41 13 00	66 00 50	906	glb. O.	Sept. 4		1
7113	2083	40 26 40	67 05 15	959	40°; gy. M.	Sept. 5	3	6
7035	2094	39 44 30	71 04 00	1,022	38½°; F. S. M.	Sept. 21		1
5656	2102	38 44 00	72 38 00	1,209	39°; glb. O.	Nov. 5		1
5657	2102	38 44 00	72 38 00	1,209	39°; glb. O.	Nov. 5		1
5695	2116	35 45 23	74 31 25	888	39°; M. S.	Nov. 11		1

The carapax is not at all compressed laterally, but about as broad as high, thin and membranaceous, and its surface naked and polished. A sharp dorsal carina extends the whole length, but is most conspicuous in front of the gastric sulcus, rises in front into a sharp lamellar crest armed with a single sharp tooth over the posterior margin of the orbit, and projects forward in a short but acute and laterally compressed rostrum, which scarcely reaches the middle of the eye-stalks.

The eye-stalks, including the eyes, are about a fourth as long as the carapax. The stalks are slender, compressed vertically, and bear a slender but obtuse papilliform process about the middle of the inner side, and just in front and outside of this there is a small spot of black pigment showing more conspicuously above than below. The eyes themselves are nearly round, scarcely as wide as the stalks, faceted, and dark brown in the alcoholic specimens.

The antennal scale is a little more than half as long as the carapax, nearly three times as long as the greatest breadth, which is near the base, from where the margins arcuately converge to a narrow but obtusely rounded tip, which is scarcely in advance of the small terminal spine of the outer margin.

The crowns of the mandibles are nearly as in *Penæus*. The mandibular palpi are very large, and reach nearly to the middle of the antennal scales; the proximal segment is more than half as broad as long, nearly twice as long as the distal segment, with the distal part of the mesial edge straight and the outer edge curved and directed inward distally, so as to narrow the segment very much at the articulation of the terminal segment, which is about twice and a half as long as broad, and ovate with the tip rounded.

The first maxilla is as in *Benthœcetes Bartletti*, except that the endognath is expanded somewhat a little way from the base.

The three distal lobes of the protognath of the second maxilla in-

crease successively in size distally, though the distal is not more than a third broader than the one next it. The endognath is nearly as long as the distal lobe of the protognath, broadly expanded near the middle, where it is more than a third as broad as long, and has a rounded prominence edged with slender setæ on the inner margin, but suddenly contracted to a very slender tip armed distally with four long setæ on the inner edge, and with two or three stouter and curved setæ on the outer edge just below these. The scaphognath is nearly as in *Benthœcetes Bartletti*, except that the posterior part is a little narrower, and not so strongly incurved.

The protopod and branchial epipod of the maxilliped are nearly as in *Benthœcetes Bartletti*, but the endopod and exopod are very different. The proximal segment of the endopod does not reach the tip of the protopod, though it is between three and four times as long as broad, the inner edge is armed distally with three or four slender spines and the rest of the way with long setæ or hairs; the second segment is a little narrower than the first, between a third and a half as long, about twice as long as broad, and margined with hairs; the terminal segment is considerably wider than the second segment, and about once and a half as long, approximately elliptical, and margined all round with long setæ or hairs. The exopod is a little longer than the endopod, unsegmented, lamellar, very thin and of nearly uniform breadth throughout, rounded at the tip, and with both edges setigerous, the setæ upon the outer edge being long and plumose.

The ischium of the first gnathopod is very short; the merus is considerably longer than the carpus and propodus combined, half as broad as long, and projects distally in a thin and broadly rounded lobe beyond the articulation of the carpus; the carpus is as long as the breadth of the merus, less than half as broad as long, and somewhat narrowed proximally; the propodus is a little shorter than the carpus, but as broad, and is slightly produced at the inner distal angle; the dactylus is about two-thirds as long as the propodus, nearly half as broad as long, obtusely pointed, and armed with a strong curved spine at the tip. The exopod is slender, reaches to about the extremity of the carpus, and is distinctly multiarticulate from near the base to the tip. The epipod is small, ovate, and bears a relatively large dendrobranchia.

The second gnathopods reach nearly to the tips of the antennal scales and are longer than either the first or second peræopods: the ischium is about a third of the entire length of the endopod, fully a third as broad as long, and very slightly narrowed proximally; the merus is as broad and about two-thirds as long as the ischium, and narrowed distally to the breadth of the carpus; the carpus is slightly shorter than the merus, and only about a third as wide; the propodus is about as long as the carpus, but a little narrower; the dactylus itself is a little broader than the propodus, but less than half as long, broadest at the middle and with the tip triangular and armed with a slender spine not

much shorter than the segment itself; both edges of the dactylus, the extremity and inner edge of the propodus, and the inner edge of the carpus, are armed with exceedingly long and slender setiform spines, and the inner sides of the proximal segments are, as usual, armed with setæ. The exopod is slender, reaches a little beyond the ischium, and is distinctly multiarticulate to near the base. The epipod is narrow, and not longer than the breadth of the ischium.

The first and second peræopods are very nearly equal in length, the first reaching about to the extremities of the peduncles of the antennæ, and the second scarcely falling short of the same point. In both the corresponding segments are of very nearly equal lengths, except the carpi, which are a very little longer in the second, but the ischia, meri, and carpi are narrower in the second than in the first: the ischium is about two-thirds as long as the merus, half as broad as long in the first and scarcely more than a third as broad as long in the second; the merus is about a third of the entire length of the endopod, slightly narrowed distally, and in the first more than a third as broad as long, but in the second scarcely more than a fifth as broad as long; the carpus in the first is about two-thirds as long and half as wide as the merus, while in the second it is longer and absolutely a little narrower than in the first; the chelæ are very nearly alike in both pairs, nearly as long and about as broad as the carpus in the second pair, with the digits slender, curved at the tips, and about two-fifths of the whole length; the edges of the chelæ are furnished with fascicles of short setæ, the tips of the digits densely clothed with much longer setæ and hairs, the inner edges of the other segments thickly clothed with plumose hairs and long setæ, and the outer edges sparsely clothed with short hairs, except on the carpus in the first pair where the outer edge is thickly hairy. The third peræopods are considerably longer and much more slender than the second, beyond which they reach by the length of their chelæ: the ischium is about as long as in the second, but narrower; the merus is twice as long as the ischium, very slender, and of nearly equal diameter throughout; the carpus is a little shorter and scarcely stouter than the merus, and very slightly thickened distally; the chela is very near the same size as in the first and second pairs, but the digits are a little longer in proportion.

The fourth and fifth peræopods are nearly alike, a little longer than the third and very slender, the fifth being a little more slender than the fourth, and both sparsely armed with long setiform spines, except upon the dactyli, which are nearly naked, long, very slightly curved, and acute.

The pleon to the tip of the telson is about twice as long as the carapax, anteriorly about as broad as the carapax and with the dorsum broadly rounded, but much compressed posteriorly, so that the sixth somite is twice as high as broad. None of the anterior somites are dorsally carinated or toothed, but the sixth, which is about twice as long as the fifth

and nearly half as high as long, has a thin dorsal carina, nearly the whole length. The pleura are rather small and the posterior angles more or less rounded in all the somites.

The telson is about two-thirds as long as the sixth somite, narrowly triangular, thickened at base, with a longitudinal sulcus the whole length above, and with a shorter one either side near the base, and with the tip truncated, narrow, and armed with a spine either side and a series of long plumose hairs between.

The inner lamella of the uropod is a little longer than the sixth somite, lancealate, and about five times as long as broad. The outer lamella is about a third longer than the inner, scarcely wider proportionally, and with the ovate tip prolonged about the width of the lamella beyond the sharp spine in which the outer margin terminates.

In both sexes the protopods of the pleopods are stout and all nearly alike; the outer rami are all very long and slender, and the inner rami of the four posterior pairs are shorter and more slender than the outer. The peculiar sexual appendage of the first pleopod in the male is carried as in *Benthœcetes Bartletti*, and, as in that species, consists of a thin, squarish plate, divided by imperfect articulations into three parts and attached by a constricted base, below which there is a small, broad, oval process; but the middle of the three parts is as large as the two others combined, inferiorly projects beyond the other parts, and at either side there is an obtuse tooth, above the inner of which there is an obtuse lobe in the margin and then a deep and narrow notch separating the middle from the inner or distal part, while on the anterior side, above the notch, there is an oblong process which may be turned either in over the distal part of the plate or out over the middle part; the distal part is thin, membranous, curls easily over upon the middle part, and is armed along the free edge with minute hooked spines. There are two oblong lamellar plates at the base of the inner ramus of the second pleopod much larger than the corresponding plates in *Benthœcetes Bartletti;* the outer plate is somewhat truncated at the extremity and the inner rounded. On the inner side of the base of the outer ramus there are two small inconspicuous dentiform processes or plates, one above the other, and with their points opposed.

Specimens in alcohol retain for a considerable time bright purple markings about the oral appendages.

Most of the specimens seen are between 30^{mm} and 40^{mm} in length, a few females only exceeding the latter measurement. Detailed measurements of a large female are given under the next species.

AMALOPENÆUS VALENS, sp. nov.

(Plate X, Fig. 2.)

This species, of which there is only one specimen (5536), is closely allied to the last, but is readily distinguished from it by the larger eyes and different petasma.

Male.—The form and areolation of the carapax are very nearly as in the last species, but the rostrum terminates in an acicular tip longer than in that species. The eye-stalks are considerably longer than in the last species, and the eyes are much larger, the diameter being about a ninth of the length of the carapax, while in the last species it is not more than a thirteenth. The antennulæ, antennæ, and oral appendages are essentially as in the last species; and, excepting the dactyli of the fourth and fifth pairs, which are broken and in part wanting, the same is true of the peræopods.

The form of all the somites of the pleon and the telson are very nearly as in the last species, but the lamellæ of the uropods are apparently slightly broader in proportion. The sexual appendages (petasma) of the first pleopods (Plate X, Fig. 2) are larger and conspicuously different in form from those of the last species, though essentially the same in general plan of structure. The broad, oval process (*a*) over the narrow base of attachment is much smaller; the inferior chitinous edge of the middle part is complicated in form, being divided into three irregular lobes, the outer of which projects in an obtuse point, and is separated from the others by a deep and irregular sinus, while the other lobes are broad, truncated, the outer longer than the inner, and separated from it by a small, narrow sinus; the inner of these lobes is separated by a broad, rounded sinus from a large, broad lobe which arises from the anterior side and projects over the membranous inner part of the appendage. This last lobe (*b*) is very much larger and proportionally broader than the corresponding lobe in the last species, and has a small lobule on the inferior side near the base. The two plates at the base of the inner ramus of the second pleopod are of nearly the same form as in the last species, but somewhat larger. There are also two small processes on the base of the outer ramus, but the proximal one is very small, low, and inconspicuous, while the distal is very much larger, conspicuous, lamellar, and ovate, with the tip directed downward away from the other process.

Measurements, in millimeters, of the single specimen, from Station 2003, March 23, north lat. 37° 16′ 30″, west long. 74° 20′ 36″, 640 fathoms, are given in the second column of the following table, and similar measurements of *A. elegans* in the first column.

	A. elegans.	A. valens.
Station	2083	2003
Sex	♀	♂
Length from tip of rostrum to tip of telson	43	38
Length of carapax, including rostrum	13.5	10.7
Length of rostrum	2.0	2.0
Hight of carapax	8.2	6.2
Breadth of carapax	7.5	6.0
Length of eye-stalk and eye	3.3	3.3
Greatest diameter of eye	1.0	1.2
Length of antennal scale	7.3	6.7
Breadth of antennal scale	2.4	2.0

	A. elegans.	A. valens.
Station	2083	2093
	♀	♂
Length of second gnathopod	14.0	13.0
Length of ischium	4.2	3.8
Length of merus	2.8	2.4
Length of carpus	2.1	2.1
Length of propodus	2.2	2.0
Length of dactylus	1.0	1.0
Length of first paræopod	11.0	9.5
Length of merus	3.3	2.9
Breadth of merus	1.2	1.0
Length of carpus	2.2	1.8
Length of chela	2.5	2.2
Breadth of chela	0.6	0.5
Length of dactylus	1.0	1.0
Length of second peræopod	11.5	....
Length of merus	3.6	....
Breadth of merus	0.7	....
Length of carpus	2.6	....
Length of chela	2.3	....
Breadth of chela	0.5	....
Length of dactylus	0.9	....
Length of third peræopod	15.5	13.0
Length of merus	5.0	3.9
Length of carpus	4.2	4.0
Length of chela	2.5	2.1
Breadth of chela	0.5	0.5
Length of dactylus	1.1	1.0
Length of fourth peræopod	19.0	....
Length of propodus	3.5	....
Length of dactylus	2.5	....
Length of sixth somite of pleon	7.1	6.4
Hight of sixth somite of pleon	3.0	2.7
Length of telson	5.0	4.6
Length of inner lamella of uropod	6.6	6.0
Breadth of inner lamella of uropod	1.3	1.2
Length of outer lamella of uropod	9.0	8.2
Breadth of lamella of uropod	1.6	1.5

ARISTEUS? TRIDENS, sp. nov.

(Plate IX, Figs. 1–6.)

The carapax is not compressed, but broad and broadly rounded above. The inferior angle of the orbit projects as a low spine, from which the anterior margin retreats slightly to a stout antennal spine projecting somewhat laterally; and below this the margin is at first longitudinal, and then transverse, leaving an opening opposite the efferent branchial passage. The rostrum is nearly as long as the rest of the carapax, with a short dorsal carina at the base, armed with three large spiniform teeth directed forward, and of which the middle one is just over the orbit, the carina extending back upon the gastric region, but not in front of the anterior tooth, and the distal two-thirds of the rostrum, directed slightly upwards, straight, slender, tapering, subcylindrical, naked, and unarmed. The cervical sulcus is not distinctly marked, except for a short distance below the hepatic region each side, but there is a deep antennal sulcus which extends back beneath the hepatic region, and a slight gastro-hepatic sulcus. There is a slight longitudinal carina on the hepatic region; a carinal ridge between the cardiac and the posterior part of the branchial region; a conspicuous carina extending back from the antennal spine, and below this a submarginal carina the whole length of the carapax, of which a broad margin below the carina is thin and membranaceous.

The eye-stalks are slender, vertically compressed, with a slight prominence (much more conspicuous in very small specimens than in adults) near the middle of the inner edge, do not reach the second segment of the antennula, and bear the small, slightly-swollen, minutely faceted, and nearly black eyes, facing obliquely inward and forward.

The antennulæ do not differ noticeably in the two sexes. The peduncle is very much shorter than the antennal scale. The body of the first segment is about half the entire length, strongly compressed vertically, but not much excavated above, and armed with a long, slender, and acute lateral process extending forward to the ultimate segment. The second segment is longer than broad and subcylindrical. The ultimate segment is smaller than the second and bears the upper flagellum about the middle of its dorsal surface, and the lower flagellum at its tip. The lower flagellum is slender, subcylindrical, and about three times as long as the carapax, excluding the rostrum. The upper flagellum is about as long as the proximal segment of the peduncle, compressed vertically, a little broader than the lower, and clothed below with short hairs, but naked and very smooth above. The second segment of the peduncle of the antenna is armed with a stout, spiniform curved process just inside the base of the scale; but the peduncle is otherwise wholly unarmed. The ultimate segment is nearly as long as the eye-stalk. The antennal scale is more than half as long as the carapax, exclusive of the rostrum, a little less than half as broad as long, the inner margin and the tip broadly rounded in outline and ciliated, the outer margin thickened, rod-like, and terminating in a short spine a considerable distance from the tip, but the rest of the scale is unusually thin and membranaceous. The flagellum is considerably longer than the lower flagellum of the antennula, about as stout, somewhat flattened vertically, smooth, and nearly naked.

The labrum is triangular, soft, fleshy, and very prominent ventrally, The lobes of the metastome are very large, covering the whole of the posterior surfaces of the crowns of the mandibles. The mandibles (Plate IX, Fig. 2) are almost exactly alike. The opposing surfaces of the crowns are triangular in outline, the posterior edge is sharp, continuous, and terminates ventrally in a triangular tip, between which and the irregular and slightly prominent molar area there is a broad and shallow depression. The proximal of the two segments of the palpus is about three times as long as broad, reaches slightly by the tip of the crown and expands a little distally; the distal segment is little more than half as long as the proximal, expands on the inner edge near the base in a triangular prominence, beyond which it is suddenly contracted, and terminates in an obtuse tip; the anterior surface of both segments is convex, smooth, and naked, the posterior surface thickly clothed with short hair.

The proximal lobe of the protognath of the first maxilla (Fig. 3) is small and obtusely ovate at the tip, the distal twice as broad and its

long mesial edge armed with stout spines, spinules and setæ. The endognath is small, narrow, obtuse at the tip, unsegmented, and not longer than the mesial edge of the distal lobe of the protognath. The distal one of the four lobes of the protognath of the second maxilla (Fig. 4) is twice as broad as the next, which is a little broader than the two subequal proximal lobes. The endognath is much shorter than the distal lobe of the protognath and tapered obliquely to a slender tip. The anterior part of the scaphognath is as long as the distal lobe of the protognath, narrow, and obtuse at the tip, while the posterior part is very short, broad, and obtusely rounded.

The protopod of the maxilliped (Fig. 5) projects forward in a straight lobe twice and a half as long as broad and rounded at the tip. The endopod is composed of three very distinct segments: the proximal segment is a little less than half the entire length and with a small rounded emargination at the distal end of the inner edge, which is ciliated and armed just below the emargination with several curved spines; the middle segment is a little more than half as long as the proximal, narrower, and reaches considerably by the protopod; the distal segment is a little shorter and slightly wider than the middle one, ovate, about three times as long as broad, and ciliated along both edges. The exopod is unsegmented, a little shorter than the endopod, narrow, obtuse at the tip, then, membranaceous, ciliated along the edges, and folded longitudinally. The lamelliform branchial epipod is as large as the protopod, the posterior part a little the larger, and both extremities obtuse. The endopod of the first gnathopod (Fig. 6) is short and stout: the merus is compressed and a little more than three times as long as broad; the three distal segments are subequal in length and together about as long as the merus; the carpus is a little longer than broad; the propudus a little narrower than the carpus and much narrowed distally; the dactylus is slender, almost spiniform, and terminates in a very slender spiniform and dorsally curved tip. The exopod is about two-thirds as long as the merus, flagelliform, slender, and multiarticulate. The epipod is about as long as the exopod, a third as long as broad, obtuse at the tip, and bears a dense branchial pyramid about as long as itself. The endopod of the second gnathopod is a little longer than the carapax excluding the rostrum and reaches to about the tip of the antennal scale: the ischium is approximately a third of the entire length; the merus, carpus, and propodus subequal in length and each slightly less than half as long as the ischium; the dactylus is about two-thirds as long as the propodus and very slender. The exopod is very small, less than half as long as in the first gnathopod. The epipod is slightly larger than in the first and bears a little larger branchial pyramid.

All the peræopods bear minute exopods, all except the posterior pair bear epipods, and all except the last two pairs bear branchial pyramids like the second gnathopods. The three pairs of chelate peræopods are similar, slender, not conspicuously compressed, and decrease in length

successively from the third, which scarcely reach the tips of the second gnathopods to the first, which only reach the bases of the chelæ of the third. The first pair are a little stouter than the others and sparsely setigerous, while the second and third are nearly naked. The meri all reach to about the same point; the carpi increase successively in length from the first, which is about two-thirds as long as the merus, to the third, which is about twice as long as the first; the chelæ increase very slightly in length, but not at all in thickness, from the first to the third, and all are slender, subcylindrical, with slender and nearly straight digits, considerably longer than the body of the chela. The fourth and fifth pairs of peræopods are alike, considerably longer than the third pair, reaching to about the tips of the antennal scales, very slender, and nearly naked, and in each the merus is about as long as the carpus and propodus combined, the carpus about as long as the propodus and dactylus combined, and the dactylus about half as long as the propodus, slender and very slightly curved.

The pleon is about twice as long as the carapax excluding the rostrum, broad anteriorly, not compressed laterally, the first, second, and third somites broadly rounded above, and the first and second unarmed, but the third and the fourth each armed with a stout laterally compressed spiniform tooth directed back over the succeeding somite. The fifth somite has a conspicuous dorsal carina terminating in a sharp tooth like that on the fourth, but much smaller. The sixth somite is about as long as the fourth and fifth combined, about three-fifths as high as long, compressed and conspicuously carinated above, the carina terminating in a small tooth over the base of the telson. The pleura are all truncated below, the first and second rounded in outline behind, the third with an obtusely rounded angle, and the fourth and fifth with a minute mucronation at the otherwise obtusely rounded angle.

The telson is about once and a third as long as the sixth somite, narrow, regularly and acutely triangular, rounder above, and armed with a very few inconspicuous dorso-marginal aculei below the middle. The inner lamella of the uropod is shorter than the telson, but reaches by its tip, is ovate-lanceolate in outline and about three and a half times as long as broad. The outer lamella is rather longer than the telson, proportionally about as broad as the inner, with the outer edge rod-like and terminating in an acute tooth some distance from the ovate tip of the lamella.

The pleopods are all highly developed and the basal portions very large, stout, and nearly alike. The outer rami, in both sexes, are very long, slender, and subcylindrical, those of the anterior pair nearly or quite as long as the five anterior somites taken together, and the posterior about half as long as the anterior. The peculiar appendage of the first pair of pleopods in the male is a squarish plate attached by one corner near the middle of the protopod, the dorsal edge thickened and distally separated from the plate as a slender stylet not projecting beyond the plate itself, and with a notch in the outer edge, from which a fold extends

across the plate. In place of this appendage, in the larger female examined, there is a small ovate lamella with a narrow fold along its inner edge, while in the smaller female there is a minute styliform process. The inner ramus of the second pleopod of the male is very slender and less than a fourth as long as the outer, but bears on the anterior side near the base an approximately round chitinous plate about $3\frac{1}{2}^{mm}$ in diameter with the inner and distal edges armed with short setæ. The inner ramus of the second pleopod of the female is similar, but wants the chitinous plate. The inner rami of the third, fourth, and fifth pairs of pleopods in both sexes are very slender, but increase successively in length to the fifth pair where they are only a little shorter than the outer rami.

The number and arrangement of the branchiæ are indicated in the following formula:

Somites.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	Total.
Epipods	1	1	1	1	1	1	1	0	(7)
Podobranchiæ	0	1	1	1	1	1	0	0	5
Arthrobranchiæ	1	1	2	2	2	2	2	0	12
Pleurobranchiæ	0	1	1	1	1	1	1	1	7
									24+(7)

Measurements in millimeters.

Station	2036	2042	2037	2043
Sex	♂	♂	♀	♀
Length from tip of rostrum to tip of telson	199	250	190+	300+
Length of carapax including rostrum	99	122	......	......
Length of rostrum	52	61	......	......
Length of carapax excluding rostrum	47	61	50	81
Breadth of carapax	23	28	23	35
Hight of carapax	25	32	25	41
Length of antennal scale	32	36.5	32.5	44.5
Breadth of antennal scale	13.5	16.0	14.0	21.4
Length of first peræopod	......	57	......	......
Length of chela	......	13.8	......	......
Breadth of chela	......	2.7	......	......
Length of dactylus	......	8.4	......	......
Length of second peræopod	......	68	......	......
Length of chela	......	14.8	......	......
Breadth of chela	......	2.8	......	......
Length of dactylus	......	9.3	......	......
Length of third peræopod	......	77	......	......
Length of chela	......	16.0	......	......
Breadth of chela	......	2.7	......	......
Length of dactylus	......	9.5	......	......
Length of fourth peræopod	......	96	......	......
Length of fifth peræopod	......	100	......	......
Length of sixth somite of pleon	19.0	25.5	20.0	28.0
Hight of sixth somite of pleon	11.0	14.0	11.5	16.5
Length of telson	28	35	28	40
Length of inner lamella of uropod	......	28.5	......	33.5
Breadth of inner lamella of uropod	......	8.3	......	9.6
Length of outer lamella of uropod	......	36.0	......	42.3
Breadth of outer lamella of uropod	......	10.5	......	12.4
Length of first pleopod	......	77	......	94
Length of its ramus	......	63	......	76
Length of second pleopod	......	72	......	86
Length of its outer ramus	......	57	......	68
Length of its inner ramus	......	11	......	17
Length of fifth pleopod	......	42	......	50
Length of its outer ramus	......	30	......	35
Length of its inner ramus	......	22	......	26

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens— ♂	Specimens— ♀	Specimens— With eggs.
		° ′ ″	° ′ ″	*Fath.*					
7054	2036	38 52 40	69 24 40	1,735	38°; glb. O.	July 18	1		......
7055	2037	38 53 00	69 23 30	1,731	38°; glb. O.	July 18		1	0
7056	2042	39 33 00	68 26 45	1,555	38½°; glb. O.	July 30	1		......
7057	2043	39 49 00	68 28 30	1,467	38¼°; gbb. O.	July 30		1	0
7015	2098	37 40 30	70 37 30	2,221	glb. O.	Oct. 1	1*y.*		......
5635	2102	38 44 00	72 38 00	1,209	39°; glb. O.	Nov. 5	1*s.*		......
5690	2115	35 49 30	74 34 45	843	39°; M. S.	Nov. 11		1	0

I refer this species to Duvernoy's genus *Aristeus* with much hesitation. It appears to have the same branchial formula as the species of *Aristeus* described by Bate from the Challenger collections and is apparently congeneric with them, but, as pointed out by Bate, Duvernoy's species is figured and described as having no epipods at the bases of the fourth peræopods, and on this account Bate "proposes provisionally" the name *Plesiopenæus* for such as have the epipods at bases of the fourth peræopods, though he describes his species as *Aristeus*. According to the description and figures, Duvernoy's species differs also, though not pointed out by Bate, in wanting pleurobranchiæ on the twelfth and thirteenth somites, so that the branchial formula of his species, as nearly as can be made out from the description and figures, would be:

Somites.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	Total.
Epipods	1	1	1	1	1	1	0	0	(6)
Podobranchiæ	?	1	1	1	1	1	1	0	5
Arthrobranchiæ	?	1	2	2	2	2	2	0	11
Pleurobranchiæ	?	1	1	1	1	0	0	1	5
	......	......	......	......	......	......	......	......	21 + (6)

The figure of the mandibular palpus of Duvernoy's species does not show the form of the distal segment characteristic of the species just described nor of *Aristeus Edwardsianus*, as figured by Miers, and it is described as composed of *three* articulations—an evident mistake. It does not seem at all improbable that Duvernoy may have overlooked the epipod and the two pleurobranchiæ, and that his species is really congeneric with the species here described.

Bate's *Aristeus armatus*, from "the Australasian Archipelago, in the North Pacific and South Atlantic," is, perhaps, closely allied to the species here described, or even specifically identical with it, but is not described with enough detail to show its affinities.

HEPOMADUS TENER, sp. nov.

(Plate IX, Figs. 7, 8.)

I refer this species, of which only a single imperfect specimen was taken, to Bate's genus *Hepomadus* with some hesitation. Bate charac-

terizes the genus wholly on the branchiæ, places it next to *Aristeus*, and refers to it two species, each based on a single injured specimen; but as our species is closely allied to *Aristeus* and agrees with *Hepomadus* in the number and arrangement of the branchiæ, it seems probable that it belongs to Bate's genus.

Male.—The carapax, the rostrum excepted, is of nearly the same form as in *Aristeus? tridens*, but is a little more slender, the dorsal part of the cervical suture is more conspicuous, and there is a well-developed hepatic spine in addition to the two spines of the anterior margin. In front of the cervical suture the dorsum is carinated and projects forward in a laterally compressed, regularly tapered, acute, and somewhat upturned rostrum about half as long as the rest of the carapax, its dorsal edge armed with two teeth near the middle and one just back of the base in the dorsal crest of the carapax proper, and the lower edge unarmed but fringed with a series of long hairs. The eye-stalks and eyes are about a fourth as long as the carapax, exclusive of the rostrum, and very nearly as in *Aristeus? tridens*, except the prominences on the inner edges of the stalks are larger, though not very much larger than in very young specimens of the *Aristeus*. The eyes are minutely faceted and black pigmented.

The peduncles of the antennulæ reach nearly to the tips of the antennal scales: the body of the proximal segment is about half the entire length, but the spiniform lateral process does not reach the extremity of the segment itself, which, however, is armed with a slender spine just outside the base of the second segment; the second segment is about twice as long as the distal. The flagella are imperfect. The second segment of the peduncle of the antenna is armed with a stout spiniform curved process just inside the base of the scale, as in *Aristeus? tridens.* The antennal scale is about half as long as the carapax, including the rostrum, about three eighths as broad as long, and in form and texture like that of *Aristeus? tridens.*

The oral appendages are very similar to those of *Aristeus? tridens*, although they show good distinctive characters. The molar areas of the mandibles are larger and the triangular ventral angles of the crowns less acute; the proximal segment of the palpus is somewhat shorter, and the expansion of the inner edge of the distal segment is a little nearer the base. The distal lobe of the protognath of the first maxilla is much narrower, so that the mesial edge is comparatively short. The second maxilla differs scarcely at all, except in having the distal lobe of the protognath a little narrower. The endopod of the maxilliped is apparently composed of four segments, though the first articulation is rather obscure and possibly the result of accident: the proximal segment is much less than half the entire length, but is proportionately about as long as in the *Aristeus?*; the second and third segments are subequal in length, but the second is narrower than the third and alone reaches beyond the tip of the protopod; the terminal segment is only about half

as long as the third, much narrower than it, and lanceolate in outline. The exopod of the maxilliped is about as long as the endopod, but at the distal fourth of its length it is suddenly narrowed into a slender flagelliform tip. The endopod of the first gnathopod is almost exactly as in *Aristeus? tridens*, but the exopod is very much larger, being considerably more than twice as long as the merus of the endopod; the epipod is apparently a little smaller, and the branchia is less dense and more slender at the tip. The second gnathopod is a little shorter than the carapax including the rostrum, much longer than the carapax excluding the rostrum, very slender, and reaches to about the tip of the antennal scale.

The first three pairs of peræopods are slender, very nearly naked and very nearly alike. The first pair reach to the tips of the second gnathopods, and the second and third each reach successively a little further forward. In each the merus is somewhat compressed and shorter than the carpus, and in the first and second pairs the lower edge is armed with a slender spine near the distal end. In the first and second pairs the chela is about as long as the carpus, in the third pair a little shorter than the carpus, and in each the digits are exceedingly slender, nearly straight, slightly separated at the bases, and much longer than the slightly swollen body of the chela. The fourth and fifth peræopods are very nearly alike, the fourth a little longer than the third, and the fifth slightly longer than the fourth; all the segments are slender, unarmed, and nearly naked; the propodus is about a sixth of the whole length, very slightly thickened proximally but narrowed distally; the dactylus is considerably shorter than the propodus, very slender, and nearly straight.

The pleon is about twice and a half as long as the carapax excluding the rostrum, the posterior somites strongly compressed laterally, but the anterior ones not at all compressed and broadly rounded dorsally. The third somite, however, is dorsally carinated and the carina projects back over the next somite in a slender compressed tooth. The fourth, fifth, and sixth somites are dorsally carinated, but the carinæ do not project posteriorly, or only very slightly. The sixth somite is about a fourth of the entire length of the pleon, very strongly compressed, and less than half as high as long.

The telson is not quite as long as the sixth somite, narrow, regularly tapered, slightly flattened above, and armed with small dorso-marginal and terminal aculei. The inner lamella of the uropod is a little longer than the telson and about four times as long as broad. The outer lamella is about a fourth longer than the inner, proportionally about as broad as the inner, and with the outer edge terminating in a triangular tooth some distance from the ovate tip of the lamella.

The pleopods are nearly as in *Aristeus? tridens*.

The number and arrangement of the branchiæ and epipods is the same as in *Aristeus? tridens*, except that there is no podobranchia at

the base of the third peræopod and only a rudimentary epipod at the base of the fourth, so that the branchial formula is—

Somites.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	Total.
Epipods	1	1	1	1	1	1	r	0	(6 + r)
Podobranchiæ	0	1	1	1	1	0	0	0	4
Arthrobranchiæ	1	1	2	2	2	2	2	0	12
Pleurobranchiæ	0	1	1	1	1	1	1	1	7
									23 + (6+r)

The pleurobranchiæ, except the last, are smaller and much more slender than the other branchiæ.

There are apparently no exopods at the bases of any of the peræopods.

Measurements in millimeters.

Length from tip of rostrum to tip of telson	72
Length of carapax including rostrum	26.0
Length of rostrum	8.2
Length of eye-stalk and eye	4.4
Greatest diameter of eye	1.5
Length of antennal scale	13.0
Breadth of antennal scale	5.1
Length of second gnathopod	23.
Length of first peræopod	25.
Length of merus	5.5
Length of carpus	7.8
Length of chela	8.0
Breadth of chela	1.3
Length of dactylus	5.5
Length of second peræopod	28.
Length of merus	6.0
Length of carpus	8.3
Length of chela	8.2
Breadth of chela	1.2
Length of dactylus	5.7
Length of third peræopod	31.
Length of merus	9.0
Length of carpus	10.0
Length of chela	9.0
Breadth of chela	1.3
Length of dactylus	5.9
Length of fourth peræopod	36
Length of propodus	5.8
Length of dactylus	4.6
Length of fifth peræopod	40
Length of sixth somite of pleon	11.3
Hight of sixth somite of pleon	5.0
Length of telson	10.4
Length of inner lamella of uropod	11.0
Breadth of inner lamella of uropod	2.8
Length of outer lamella of uropod	14.0
Breadth of outer lamella of uropod	3.4

Station 2099, October 2, north lat. 37° 12′ 20″, west long. 69° 30′, 2,949 fathoms, globigerina ooze—1 ♂ in rather bad condition, No. 5464. The specimen is labeled "White when found."

HYMENOPENÆUS MICROPS, sp. nov.

(Plate X, Fig. 1.)

This is very closely allied to *H. debilis* Smith (Bull. Mus. Comp. Zool., x, p. 91, pl. 15, figs. 6–11, pl. 16, figs. 1–3, 1882), but is readily distinguished by the very much smaller and nearly hemispherical eyes, which in *H. debilis* are large and reniform as in the typical species of *Penæus*. The species is represented by two females only, and one of these imperfect.

As in the typical species the whole integument is very thin and delicate so that the form of the body is not very well preserved in the alcoholic specimens. The carapax is slightly compressed laterally and dorsally carinated nearly the whole length, but the carina is indistinct back of the cervical suture. The rostrum is horizontal, less than a third as long as the rest of the carapax, narrow vertically, tapers regularly to an acute point, is wholly unarmed below, and armed above with five nearly equidistant teeth, of which the posterior is just back of the orbit on the carapax proper, while far back on the gastric region there are two other teeth in the dorsal carina.

The eyes are black, scarcely reach the middle of the proximal segment of the antennula, are approximately hemispherical and very small, the diameter equaling only about half the length to the base of the stalk.

The antennal scale is about half as long as the carapax excluding the rostrum, and rather more than four times as long as broad.

The oral appendages are almost exactly as in *H. debilis*. In the description and figure of the last-mentioned species I overlooked the proximal articulation in the endopod of the maxilliped, which is composed of four segments. In both species the proximal segment is less than half the whole length, broad at base, but the inner margin abruptly contracted beyond the middle, leaving an angular projection, which is armed with long setæ; the three distal segments are approximately equal in length; the second segment curves round beyond the end of the protopod; the last two are very narrow and margined with a regular series of slender plumose setæ, which are much longer upon the outer than upon the inner edge.

The second gnathopods and all the peræopods except the fifth pair have very minute rudimentary exopods as in *H. debilis*. The three pairs of chelate peræopods are very nearly as in *H. debilis*. The fourth and fifth peræopods are very long, slender, and nearly naked. The fourth are about as long as the carapax including the rostrum; the merus and carpus are subequal in length, and together make fully two-thirds the whole length; the propodus is slightly more than a fourth as long as

the merus, and the dactylus about three-fifths as long as the propodus. The fifth pair are considerably longer than the fourth; the merus is a little longer, and the carpus about as long as in the fourth; the propodus is fully half as long as the carpus, and more than twice as long as in the fourth, and the dactylus is very slender and only about a fourth as long as the propodus.

The three anterior somites of the pleon are rounded above, but the fourth, fifth, and sixth are compressed and sharply carinated dorsally, and on the sixth somite the carina terminates in a small tooth at the posterior margin. The telson is much longer than the sixth somite, tapers regularly to a narrow tip, which, however, is not quite perfect in either of the specimens, and is armed either side about a fourth of the way from the tip to the base with a very long and slender spine.

Measurements in millimeters.

Station	2037	2076
Sex	♀	♀
Length from tip of rostrum to tip of telson	51	....
Length of carapax including rostrum	19.2	....
Length of carapax excluding rostrum	15.0	22.0
Length of rostrum	4.3	....
Length of eye-stalk and eye	2.4	3.3
Greatest diameter of eye	1.2	1.6
Length of antennal scale	8.0	10.0
Breadth of antennal scale	2.2	2.8
Length of second gnathopod	24.0	32.0
Length of first peræopod	16.5	21.0
Length of carpus	4.2	5.4
Length of chela	2.8	3.7
Length of second peræopod	21.0	27.0
Length of carpus	7.5	10.0
Length of chela	3.2	3.7
Length of third peræopod	27.0	33.0
Length of carpus	11.0	14.0
Length of chela	3.7	4.5
Length of fourth peræopod	38.0	45.0
Length of propodus	3.4	4.3
Length of dactylus	2.0	2.4
Length of fifth peræopod	43.0	54.0
Length of propodus	7.4	9.3
Length of dactylus	1.9	2.1
Length of sixth somite of pleon	6.5	8.0
Hight of sixth somite of pleon	3.5	4.3
Length of telson	8.5	11.0
Length of inner lamella of uropod	....	8.7
Length of outer lamella of uropod	....	11.0

Station 2037, July 18, north lat. 38° 50′, west long. 69° 23′ 30″, 1,731 fathoms, globigerina ooze, temperature 38°—1 ♀ (7147).

Station 2076, September 4, north lat. 41° 13′, west long. 60° 00′ 50″, 906 fathoms, blue mud—1 ♀ (7148).

SERGESTIDÆ.

SERGESTES ARCTICUS Kröyer.

Smith, Proc. Nat. Mus., iii, p. 445, 1881; Bull. Mus. Comp. Zool., x, p. 96, pl. 16, fig. 4, 1882.

(Plate VIII, Fig. 2.)

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens. ♂	Specimens. ♀
		° ′ ″	° ′ ″	*Fath.*				
5550	2002	37 20 42	74 17 36	641	gn. M.	Mar. 23	1	3
7126	2003	27 16 30	74 20 36	640	....	Mar. 23	1	
5596	2023	37 48 00	74 01 30	377	S. bu. M.	May 21	6	12
5594	2024	40 02 10	70 27 00	221	40½°; dk. gn. M.	May 25	16	15
5587	2025	40 02 05	70 27 00	239	40½°; S. gn. M.	May 25	1	3
5556	2030	39 29 45	71 43 00	588	bu. M.	May 26		2
7100	2045	40 04 20	68 43 50	373	40°; bu. M.	July 31	5	1
7101	2047	40 02 30	68 49 40	389	52°; bu. M.	July 31	1	1
7102	2049	39 43 40	69 20 00	1,025	39°; bu. M.	Aug. 1	2	3
7103	2076	41 13 00	66 00 50	906	bu. M.	Sept. 4		8
7123	2110	35 12 10	74 57 15	516	40°; bu. M.	Nov. 9	1	
5653	2111	35 09 50	74 57 40	938	gn. M.	Nov. 9		1
5697	2116	35 45 23	74 31 25	888	39°; bu. M.	Nov. 4	1	1

In this species there is an epipod and a well-developed podobranchia at the base of the first gnathopod, and above its base a simple lamella in place of a pleurobranchia, a large anterior pleurobranchia with a simple lamella back of it on each of the three succeeding somites, a large anterior and a small posterior pleurobranchia on the antepenultimate somite, and on the penultimate somite two small branchiæ, of which the posterior is very much the smaller, while the last somite is without branchiæ; or, indicating the simple pleurolamellæ by accents, branchial formula may be indicated as follows:—

Somites.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XVI.	Total.
Epipods	1	1	0	0	0	0	0	0	(2)
Podobranchiæ	0	1	0	0	0	0	0	0	1
Arthrobranchiæ	0	0	0	0	0	0	0	0	0
Pleurobranchiæ	0	0′	1′	1′	1′	2	2	0	7
									8+(2)

The structure of the branchiæ themselves, in this and in the two following species as well, is very different from that in *Penæus*, or any of the Penæidæ described in this paper. The branchiæ are pinnate in form, and each pinna is a complete phyllobranchia; that is, they are compound phyllobranchiæ, while those of *Penæus* are compound trichobranchiæ. The structure is more like that in *Sicyonia* (judging by Bate's description of the branchiæ of that genus) than that in *Penæus*.

The first peræopods are subchelate, and the dactyli of the second gnathopods and the propodi of the first, second, and third peræopods are mul-

tiarticulate, as in the two following species, but the articulations are more conspicuous. These structural characters of the peræopods are, however, undoubtedly characteristic of all the species of the genus.

SERGESTES ROBUSTUS Smith.

Sergestes, sp., Smith, Proc. National Mus., iii, p. 445, 1881. *Sergestes robustus* Smith, Bull. Mus. Comp. Zool., x, p. 97, pl. 16, figs. 5–8b, 1882.

(Plate 8, Figs. 3–6*b*.)

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens. ♂	♀
		° ′ ″	° ′ ″	*Fath.*				
5549	2002	37 02 42	74 17 36	641	gn. M.	Mar. 23	1	
5516	2003	37 16 31	74 20 36	640	....	Mar. 23	4	

Male.—The carapax is strongly compressed, the breadth being considerably more than the height at the base of the antennæ, but much less than the greatest height posteriorly, which is fully twice that at the base of the antennæ. The dorsum is broadly rounded to the base of the rostrum, which rises rather abruptly from the dorsum, is very thin, acutely triangular, and extends a little forward of the truncated middle lobe of the ophthalmic somite.

The eye-stalks to the tips of the eyes are about two-fifths as long as the antennal scales, and the diameter of the eye itself at least half the length. The peduncle of the antennula is fully a fourth longer than the antennal scale, the first segment scarcely half as long as the antennal scale, and the second and third successively a little shorter; all the segments are very stout, the diameter in the second and third being equal to more than half the length. The proximal segment of the upper or major flagellum is scarcely more than a fourth as long as the distal segment of the peduncle, and scarcely longer than the proximal segment of the flagellum, which is modified as in the allied species. The antennal scale (Fig. 5) is about half as long as the carapax along the dorsal line, about a third as broad as long, and much broader at the tip than in the allied species.

The oral appendages do not differ essentially from the oral appendages of *P. Frisii* and *arcticus* as figured by Kröyer.

The second gnathopods reach by the tips of the antennal scales fully the length of their dactyli, and are about as stout as the third peræopods: all five segments of the endopod are approximately equal in length, though the dactylus is slightly shorter than the others, and all are armed with very slender spines; the dactylus is slender and multiarticulate, being composed of about five segments, and tipped with two or three spines. The first peræopods fall a little short of the tips of the

antennal scales: the merus is about twice as long as the carpus and about as long as the propodus, which is very slender, composed of about ten segments, and armed, like the ischium, merus, and carpus, with exceedingly long, and for the most part simple, setiform spines, and at the proximal extremity with a tuft of serate setæ, corresponding to a similar tuft on the distal extremity of the carpus; the dactylus is very minute, but perfectly distinct, and armed with an exceedingly long and slender spiniform seta, while the tip of the propodus is armed with a very much shorter spine. The second peræopods reach to about the tips of the second gnathopods: the merus is a little longer than in the first; the carpus twice as long as in the first and only a little shorter than the merus; the propodus is longer than the merus, composed of about twelve segments, and armed very nearly as in the first, except that the tuft of setæ at the proximal extremity, with the corresponding one on the carpus, is wholly wanting, while the digits of the well-developed chela (Fig. 4) are considerably longer than the diameter of the propodus at their base, slender, nearly straight, and armed at the tips with a dense brush of setæ, most of which are serrate. The third peræopods are almost exactly like the second, except that they are considerably longer, reaching by the second by about half the length of their dactyli. The fourth peræopods reach by the middle of the antennal scale, are very much stouter than the third pair, and the endopods are composed of only four segments each, the dactylus, apparently, being wanting: the ischium, carpus, and propodus (or the proximal and the two distal segments) are subequal in length, while the merus (or antepenultimate segment) is about once and a half as long as each of the others: the merus is about six times as long as broad, and, like the ischium, densely ciliated along both edges, but the cilia on the lower edge are several times longer than those upon the upper, which are not as long as the breadth of the segment; the carpus is slightly broader than the merus, being more than a fourth as broad as long, ciliated like the merus along the lower edge, but the upper edge naked; the propodus (or ultimate segment) is a little less than a fifth as broad as long, ovate at the tip, and has the lower edge ciliated and the upper naked like the carpus. The fifth peræopods are a little more than half as long as the fourth, and their endopods are composed of the same number of segments: the ischium and carpus are subequal in length, the merus is a little longer and the propodus a little shorter, and all the segments are ciliated along both edges, though the cilia upon the lower edge are much longer than those upon the upper; the merus is about a fourth as broad as long, and considerably broader than the ischium or carpus; the carpus is less than a fourth as broad as long, and slightly tapered distally; the propodus is a little less than a fifth as broad as long, and regularly tapered from near the base to the acute tip.

The pleon, excluding the telson, is nearly twice as long as the carapax along the dorsal line, is considerably compressed, though anteriorly about as broad as the carapax, and, like the carapax, rounded above,

but with a shallow median sulcus on the third and fourth somites. [There are apparently similar sulci on the abdomen of *S. arcticus.*] The pleura of the first three somites are large and project backward in an angle, while the pleura of the fourth and fifth somites project backward quite as far, but have the outline more rounded. The sixth somite is about as long as the antennal scale, considerably more than half as high as long, and strongly compressed.

The telson is considerably shorter than the sixth somite, flattened and slightly sulcated above, with a deep lateral groove each side, acutely angular at the tip, and ciliated along the edges. The inner lamella of the uropod is about as long as the telson, about three times as long as broad, and lanceolate at the top. The outer lamella is between a third and a fourth longer than the inner, about a fourth as broad as long, the outer margin terminates in a strong tooth about two-thirds of the way from the base to the tip, and the tip is narrow, but rounded.

The peculiar sexual appendages (Fig. 6) of the first somite of the pleon have essentially the same structure as in *S. arcticus*, but are much more complicated than would be inferred from the figures of that species given by Kröyer. The appendages of the two sides are usually hooked together along the middle line (*h*), but are really entirely distinct. Each is attached by a narrow process (*a*) to the protopod of the pleopod, and is divided by more or less distinct sutures into three portions. The outer portion, that next the protopod, projects above the point of attachment in a narrow process, and below the point of attachment in a broad lamellar lateral expansion, and below this in a long, flat, chitinous stylet (*b*) terminating in a sharp hook below a rounded sinus in the extremity. The middle portion projects below and alongside of, but far beyond, the hooked stylet (*b*), in a complicated appendage divided distally into three membranaceous and hook-bearing processes (*e*, *f*, *g*) and bearing two slender and unarmed stylets (*c*, *d*); and each of the membranaceous processes is armed along one edge with a series of peculiar chitinous hooks retracted within invaginated papillæ (Fig. 6^{b}), and at the tip with a larger and somewhat differently shaped but similarly retracted hook (Fig. 6^{a}). The lateral hooks themselves are semi-mushroom shaped, like those which serve to hook together the inner rami of the pleopods in many crustaceans, and very much like those along the mesial edge (*h*) of this same appendage but larger. The terminal hooks are more properly hook-shaped, as shown in the figure, but are broad at the tips. The invagination of the membrane around the hooks is possibly due to contraction in the alcoholic specimens, but the hooks are similarly retracted in all the specimens of *S. arcticus* which I have examined, their bases appear to be connected with strong muscular fibers, and I think there is little doubt that the hooks are capable of being retracted in life. The mesial portion of the appendage is thin, lamellar, longitudinally folded, and armed along the mesial edge with great numbers of semi-mushroom-shaped hooks, which serve to attach together the appendages of the two sides.

The branchiæ are the same in number and have the same arrangement as in *S. arcticus*, but the posterior branchia on the twelfth (antepenultimate) somite is nearly as large as the anterior, which is the largest of the series, and the branchiæ of the penultimate somite are very nearly alike, and not very much smaller than the pair next in front of them.

Measurements in millimeters.

Station	2002	2003
Sex	♂	♂
Length from tip of rostrum to tip of telson	64	73
Length of carapax including rostrum	19.3	21.6
Length of rostrum	2.0	2.5
Hight of carapax anteriorly	4.5	5.0
Hight of carapax posteriorly	9.2	10.5
Breadth of carapax	7.2	7.5
Length of eye-stalk and eye	3.6	4.1
Greatest diameter of eye	2.0	2.2
Length of peduncle of antennula	12.5	14.6
Length of distal segment	3.3	4.0
Length of antennal scale	9.2	10.2
Breadth of antennal scale	3.1	3.4
Length of sixth somite of pleon	9.8	11.1
Hight of sixth somite of pleon	6.2	7.0
Breadth of sixth somite of pleon	3.4	4.0
Length of telson	8.1	9.1
Length of inner lamella of uropod	8.0	8.9
Breadth of inner lamella of uropod	2.7	2.9
Length of outer lamella of uropod	11.9	13.0
Breadth of outer lamella of uropod	3.0	3.2

SERGESTES MOLLIS, sp. nov.

Sergestes, sp. indet., Smith, Bull. Mus. Comp. Zool., x, p. 100, 1882.

This species resembles *S. robustus* considerably in form and size, but the whole integument is very soft and all parts of the animal exceedingly fragile; the cephaloperæon is scarcely at all compressed, the rostrum is small and obtuse, and the eyes are very little larger than the eye-stalks.

Male.—The carapax is broad and the dorsum broadly rounded to the base of the small obtuse rostrum, which projects very little anteriorly. The cervical suture is much more conspicuous than in either *S. robustus* or *arcticus*. The eye-stalks to the tips of the eyes are nearly a sixth as long as the carapax and about a third as long as the antennal scale, and the diameter of the eye itself is about a third of the length, or very little greater than the stalk. The peduncle of the antennula is nearly as in *S. robustus*, very stout, much longer than the antennal scale, and more than half as long as the carapax; the proximal segment is about half as long as the antennal scale, and the middle and distal segments approximately equal in length. The proximal segment of the upper or major flagellum is nearly half as long as the distal segment of the peduncle and more than twice as long as the proximal segment of the lower flagellum, which is nearly as in the allied species. The antennal scale is less than half as long as the carapax, fully a third as broad as long, as broad at the tip as in *S. robustus*, and without any tooth or spine at the distal end of the non-ciliated outer edge, or with a very minute one.

The gnathopods and peræopods are essentially as in *S. robustus*, except that the fourth and fifth peræopods are much narrower and very nearly as in *S. arcticus*.

The pleon is broad anteriorly, but strongly compressed posteriorly, and the dorsum rounded. The sixth somite is shorter than the antennal scale, more than half as high as long, and very strongly compressed. The telson is about as long as the sixth somite, sulcated as in *S. robustus*, and rather obtusely triangular at the tip, which, however, is mucronate. The inner lamella of the uropod is about four times as long as broad and regularly lanceolate in outline, without any angular expansion near the middle of the outer edge. The outer lamella is nearly a third longer than the inner, about four and a half times as long as broad, and the outer margin terminates in a tooth about two-ninths of the length, or the width of the lamella, from the tip.

The peculiar sexual appendages (petasma) of the first pair of pleopods are very nearly as described and figured for *S. robustus*, although there is a little difference in the form and proportions of the hook-bearing processes and unarmed stylets of the main branch of each appendage: the lateral unarmed stylet (marked *c* in the figure of *S. robustus*) is stouter than in that species and truncated at the tip, while the mesial stylet (*d*) is nearly as long as the hook-bearing process (*g*) with which it is connected at base.

The *females* are considerably larger and stouter than the males, the peduncles of the antennulæ are apparently a little shorter, and the eyes slightly smaller.

Although a considerable number of specimens have been taken by the Albatross, none of them are perfect and most of them are in very bad condition.

The branchiæ are all much smaller than in *S. robustus*, the posterior pleurobranchia of the twelfth (antepenultimate) somite is replaced by a simple lamella like that upon the somite next in front, and the two branchiæ of the penultimate somite are very small, as in *S. arcticus*.

Three specimens (7106) from Station 2051 give the following measurements, of which some, on account of the imperfections and soft condition of the specimens, are only approximate:

Sex	♂	♀	♀
Length from tip of rostrum to tip of telson	50	57	72
Length of carapax along dorsum	18	21	26
Length of eye-stalk and eye	2.9	3.0	3.0
Greatest diameter of eye	1.0	0.9	1.1
Length of peduncle of antennula	9.8	10.0	13.0
Length of its distal segment	2.6	2.6	3.2
Length of antennal scale	8.2	8.8	.....
Breadth of antennal scale	2.8	3.3	.....
Length of sixth somite of pleon	8.0	9.0	10.8
Hight of sixth somite of pleon	4.2	4.8	5.8
Length of telson	8.1	8.0	10.0
Length of inner lamella of uropod	8.0	.....	.....
Breadth of inner lamella of uropod	2.0	.....	.....
Length of outer lamella of uropod	10.8	.....	.....
Breadth of outer lamella of uropod	2.4	.....	.....

Specimens examined.

Catalogue number.	Station number.	Locality— N. lat.	Locality— W. long.	Depth.	Temperature and nature of bottom.	Date.	Specimens. ♂	Specimens. ♀
		° ′ ″	° ′ ″	*Fath.*				
7121	2002	37 20 42	74 17 36	641	gn. M.	Mar. 23		1*s.*
5573	2018	37 12 22	74 20 04	788	39°; bu. M.	May 7		1
7104	2040	38 35 13	68 16 00	2, 226	glb. O.	July 19		1
7105	2045	40 04 20	68 43 50	373	40°; bu. M.	July 31		1
7106	2051	39 41 00	69 20 20	1, 106	39°; bu.M.glb.O.	Aug. 1	3	3
7107	2083	40 26 40	67 05 15	959	40°; gy. M.	Sept. 5		2
7028	2093	39 42 50	71 01 20	1, 000	39°; F. S. M.	Sept. 21	1	
7029	2094	39 44 30	71 04 00	1, 022	38½°; F. S. M.	Sept. 21		1
7030	2097	37 56 20	70 57 30	1, 917	glb. O.	Oct. 1	1	1
5440	2099	37 12 20	69 39 00	2, 949	glb. O.	Oct. 2		1
5442	2099	37 12 20	69 39 00	2, 949	glb. O.	Oct. 2	frag.	
5460	2099	37 12 20	69 39 00	2, 949	glb. O.	Oct. 2		1
7031	2099	37 12 20	69 39 00	2, 949	glb. O.	Oct. 2	1	1
5450	2100	39 22 00	68 34 30	1, 628	37½°; glb. O.	Oct. 3	1	1
7032	2101	39 18 30	68 24 00	1, 686	37°; glb. O.	Oct. 3	1	
5648	2103	38 47 20	72 37 00	1, 091	39°; glb. O.	Nov. 5	1	
5652	2103	38 47 20	72 37 00	1, 091	39°; glb. O.	Nov. 5	1	2
5706	2104	38 48 00	72 40 30	991	41½°; bu. M.	Nov. 5		1
5670	2105	37 50 00	73 03 50	1, 395	41°; glb. O.	Nov. 6	frag.	
5647	2110	35 12 10	74 57 15	516	40°; bu. M.	Nov. 9		1
7122	2116	35 45 23	74 31 25	888	39°; bu. M. S.	Nov. 11		1

NEW HAVEN, CONN., *February* 16, 1884.

EXPLANATION OF PLATES.

All the figures on Plates I, II, III, IV, V, and VII; Fig. 1, Plate VI; Figs. 1 and 3, Plate VIII; Figs. 1 to 6, Plate IX; and Fig. 1, Plate X, were drawn by J. H. Emerton; all the other figures were drawn by the author.

A considerable number of the figures have been made from specimens taken by the Fish Hawk before 1883, but the numbers of the stations from which the specimens figured came are given in all cases.

PLATE I.

FIG. 1.—*Collodes robustus* Smith. Dorsal view of young male, from Station 1036, enlarged two diameters. The mud has been removed from the front and right side, but the other side is represented covered with mud, etc., as when taken.

FIG. 1*a*.—Right chela of the same specimen, seen from the inside, enlarged four diameters.

FIG. 2.—Large male of the same species, from Station 940, dorsal view, natural size.

FIG. 2*a*.—Ventral view of the front and oral regions of the same specimen, enlarged two diameters.

FIG. 2*b*.—Right chela of the same specimen, seen from the inside, natural size.

FIG. 3.—*Euprognatha rastellifera* Stimpson. Dorsal view of male, from Station 922, enlarged two diameters.

FIG. 3*a*.—Lateral view of the carapax of the same specimen, enlarged the same amount.

PLATE II.

FIG. 1.—*Ethusina abyssicola*, sp. nov. Dorsal view of male, from Station 2037, enlarged two diameters.

FIG. 1*a*.—Ventral view of front and oral region of the same specimen, enlarged four diameters.

FIG. 2.—*Latreillia elegans* Roux. Dorsal view, with the distal portions of the peræopods omitted, of female, from Station 940, enlarged two diameters.

FIG. 2*a*.—Lateral view of the same specimen, enlarged the same amount.

PLATE III.

FIG. 1.—*Latreillia elegans*. Dorsal view of male, from Station 940, natural size.

FIG. 2.—*Catapagurus gracilis* Smith. Dorsal view of male, from Station 871, enlarged four diameters.

FIG. 3.—Dorsal view of chelipeds of female of the same species, from Station 871, enlarged four diameters.

PLATE IV.

FIG. 1.—*Catapagurus Sharreri* A. M.-Edwards. Dorsal view of female, in carcinœcium formed of *Epizoanthus Americanus* Verrill, from Station 877, enlarged two diameters.

FIG. 2.—Dorsal view of male of the same species, removed from the carcinœcium, enlarged two diameters.

FIG. 3.—*Sympagurus pictus* Smith. Dorsal view of carapax, anterior appendages and chelipeds of male, from Station 924, natural size.

FIG. 4.—*Eupagurus pollicaris* Stimpson. Dorsal view of the carapax and anterior appendages of male, from Station 1166, natural size.

PLATE V.

FIG. 1.—*Pandalus leptocerus* Smith. Lateral view of female, from Station 1160, enlarged two diameters.

FIG. 2.—*Pasiphaë princeps*, sp. nov. Lateral view of female, from Station 2095, one-half natural size.

FIG. 3.—*Parapasiphaë cristata*, sp. nov. Dorsal view of anterior part of carapax and anterior appendages of female, from Station 2100, natural size.

FIG. 4.—*Parapasiphaë sulcatifrons*, sp. nov. Dorsal view of carapax and anterior appendages of female, from Station 2099, natural size.

PLATE VI.

FIG. 1.—*Parapasiphaë sulcatifrons*. Lateral view of female, from Station 2034, natural size.

FIG. 2.—Ventral view of mandibles of female, from Station 2034, enlarged eight diameters.

FIG. 3.—First maxilla of the right side of the same specimen, enlarged eight diameters.

FIG. 4.—Second maxilla of the left side of the same specimen, enlarged six diameters.

FIG. 5.—Maxmilliped of the right side of the same specimen, enlarged six diameters.

FIG. 6.—First gnathopod of the right side of the same specimen, enlarged six diameters.

FIG. 7.—Second gnathopod of the right side of the same specimen, enlarged three diameters.

PLATE VII.

FIG. 1—*Nematocarcinus ensiferus* Smith. Lateral view of female, from Station 2035, natural size.

FIG. 2.—*Notostomus robustus*, sp. nov. Lateral view of female, from Station 2074, natural size.

PLATE VIII.

FIG. 1.—*Acanthephyra Agassizii* Smith. Lateral view of male, from Station 2034, natural size.

FIG. 2.—*Sergestes arcticus* Kröyer. Antennal scale of the right side of a male, from Station 1030, enlarged four diameters.

FIG. 3.—*Sergestes robustus* Smith. Lateral view of male, from Station 893, enlarged two diameters.

FIG. 4.—Distal extremity of chela of the second peræopod of the left side of another male, from the same station, enlarged twenty-four diameters.

FIG. 5.—Antennal scale of the right side of the same specimen, enlarged four diameters.

FIG. 6.—Appendage (petasma) of the protopod of the first pleopod of the right side of the same specimen, seen from in front, enlarged eight diameters; *a*, point of attachment to the protopod; *b*, hooked stylet; *c*, *d*, unarmed stylets; *e*, *f*, *g*, terminal processes armed with invaginated hooks; *h*, mesial line where the appendages of the two sides are hooked together.

FIG. 6*a*.—Invaginated hook at the tip of process *f*, enlarged one hundred diameters.

FIG. 6*b*.—Invaginated hook from the side of the same process, enlarged one hundred diameters.

PLATE IX.

FIG. 1.—*Aristeus? tridens*, sp. nov. Lateral view of male, from Station 2036, one-half natural size.

FIG. 1*a*.—Dorsal view of the carapax and anterior appendages of the same specimen, one-half natural size.

FIG. 2.—Mandible of the right side of female, from Station 2043, ventral and dorsal views, natural size.

FIG. 3.—First maxilla of the right side of the same specimen, natural size.

FIG. 4.—Second maxilla of the right side of the same specimen, natural size.

FIG. 5.—Maxilliped of the right side of the same specimen, natural size.

FIG. 6.—First gnathopod of the right side of the same specimen, natural size.

FIG. 7.—*Hepomadus tener*, sp. nov. Lateral view of front of carapax and eye of male from Station 2099, enlarged four diameters.

FIG. 8.—Distal part of third peræopod of right side of the same specimen, enlarged four diameters.

PLATE X.

FIG. 1.—*Hymenopenæus microps*, sp. nov. Lateral view of female, from Station 2037, enlarged two diameters.

FIG. 2.—*Amalopenæus valens*, sp. nov. Appendage (petasma) of the protopod of the first pleopod of the right side of male, from Station 2003, seen from in front, enlarged twelve diameters; *a*, oval process over the base of attachment to the protopod *c*; *b*, broad lobe projecting over the membranous inner part of the appendage.

FIG. 3.—*Benthesicymus?* sp. indet. Distal part of maxilliped of the right side of specimen, from Station 2042, enlarged eight diameters.

FIG. 4.—First gnathopod of the right side of the same specimen, enlarged eight diameters.

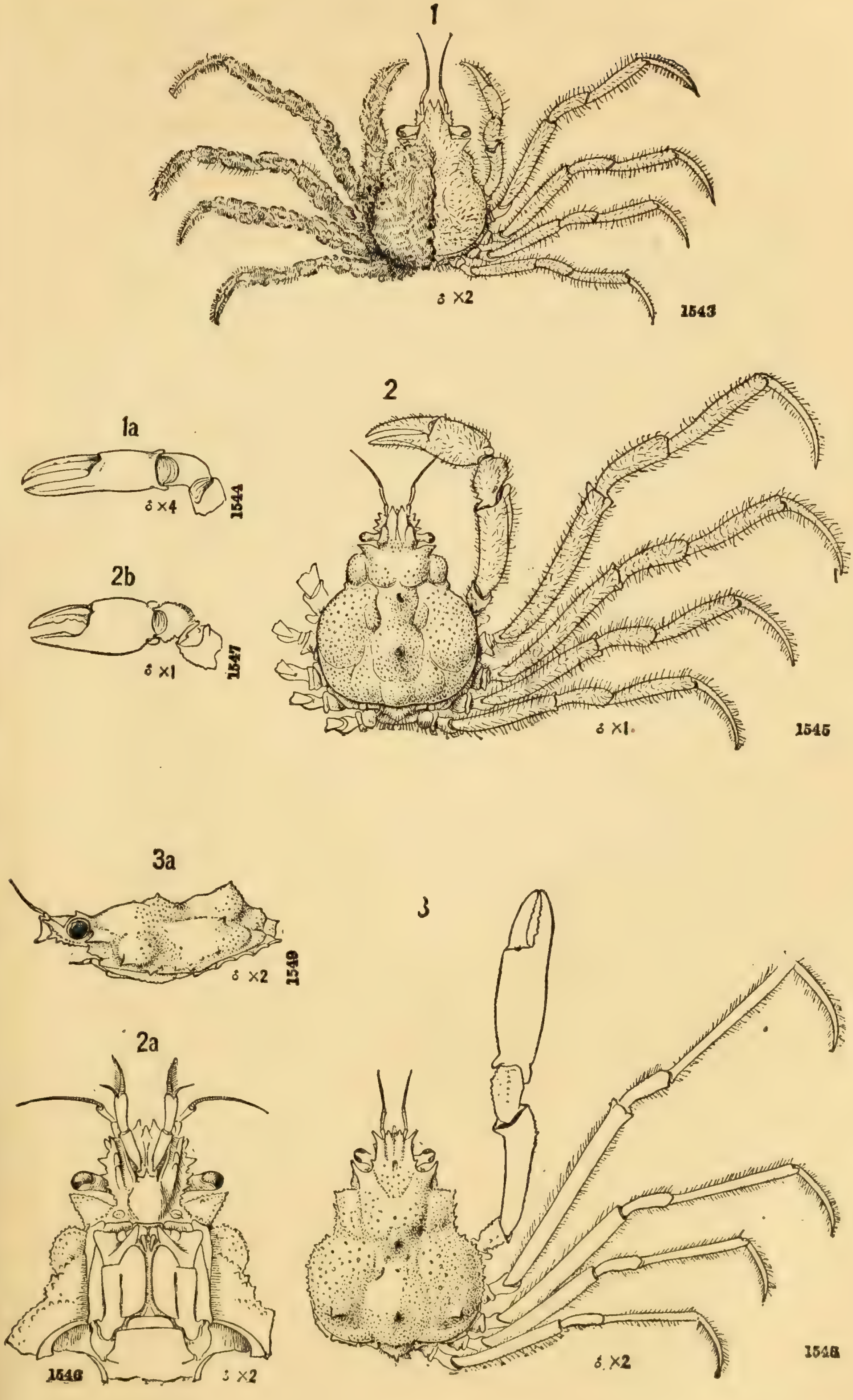
FIG. 5.—Distal part of second gnathopod of the same specimen, enlarged eight diameters.

FIG. 6.—*Benthesicymus ? carinatus*, sp. nov. Distal part of maxilliped of left side of female, from Station 2094, enlarged eight diameters.

FIG. 7.—First gnathopod of the left side of the same specimen, enlarged four diameters.

FIG. 8.—*Benthœcetes Bartletti* Smith. Distal part of second gnathopod of male, from Station 2072, enlarged eight diameters.

PLATE I.



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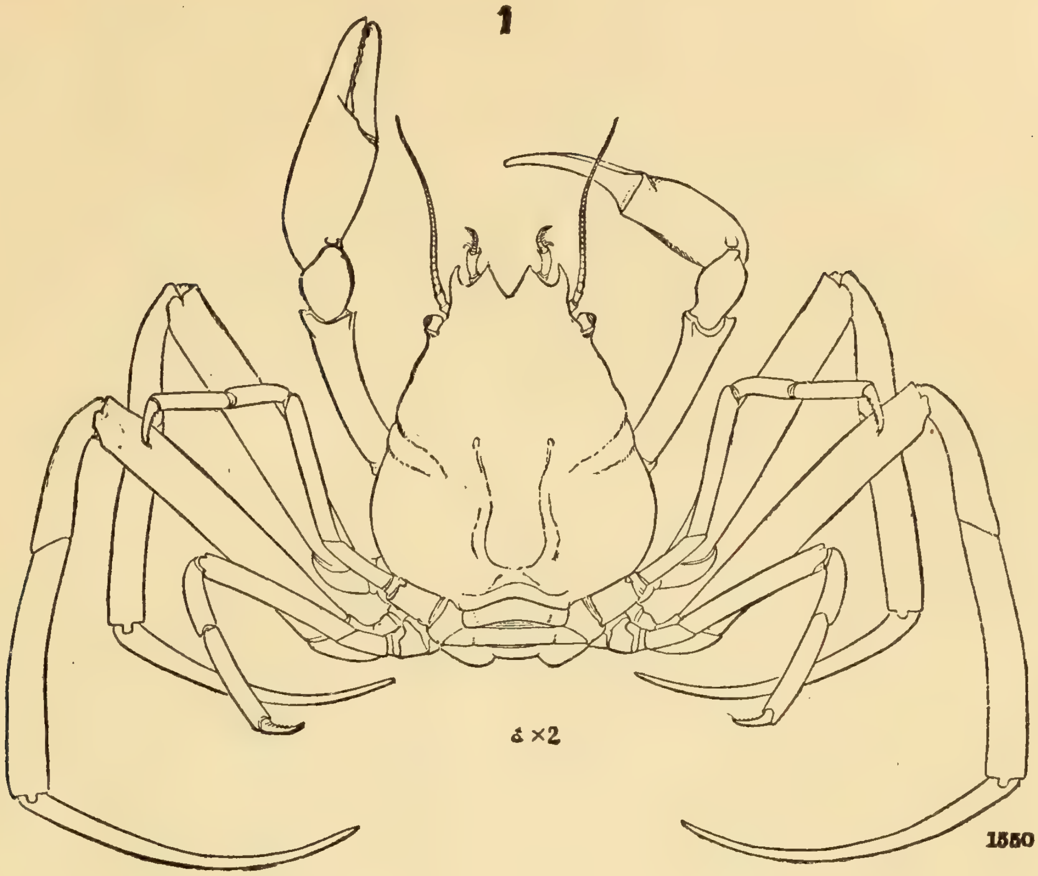

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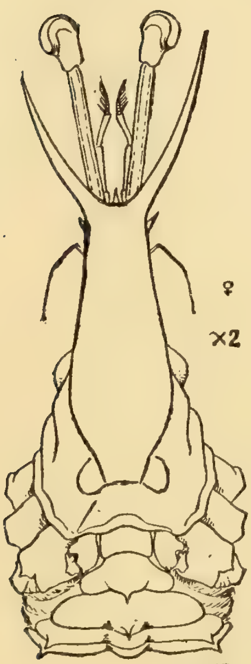

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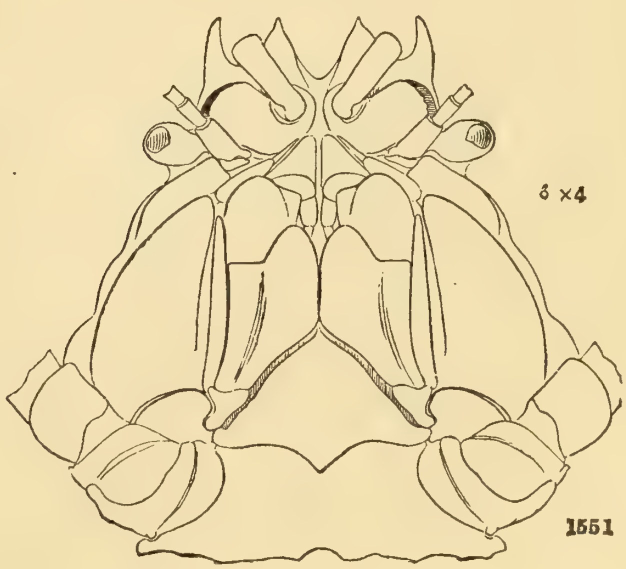

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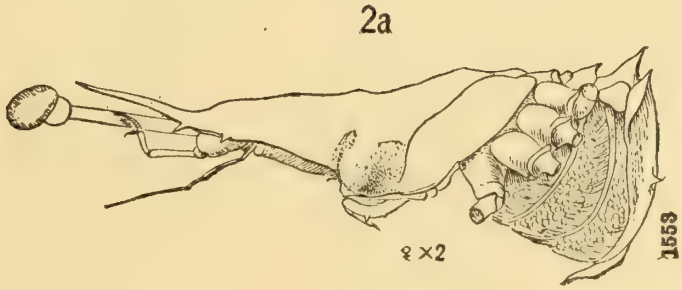

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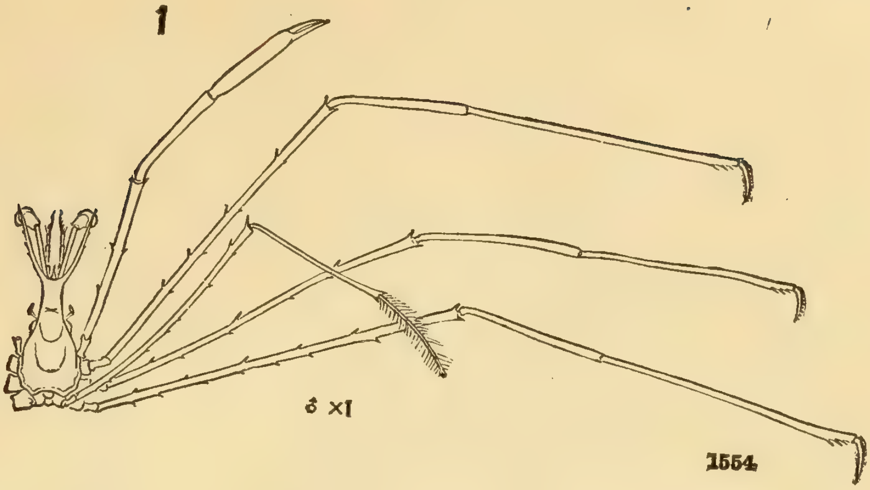

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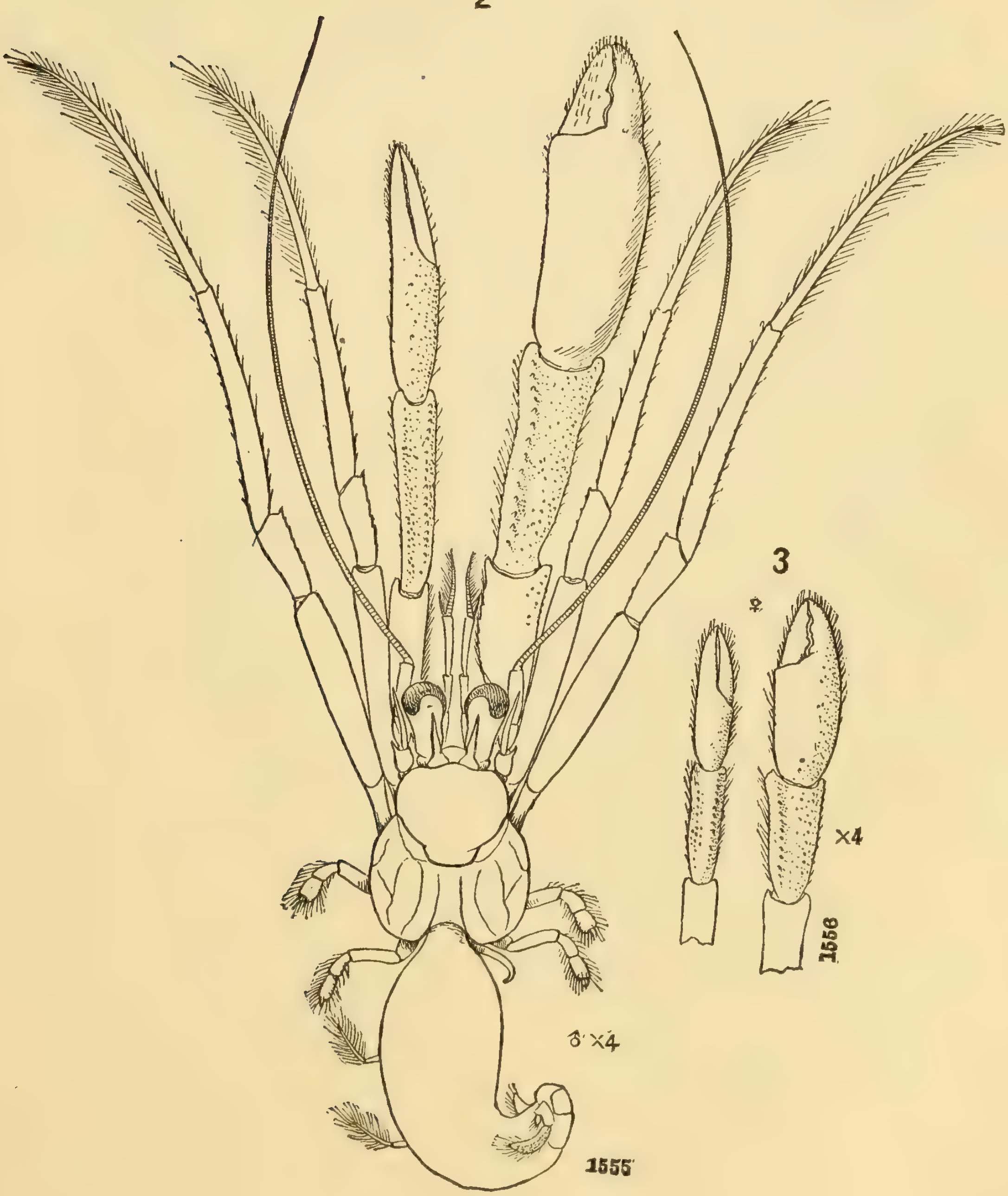

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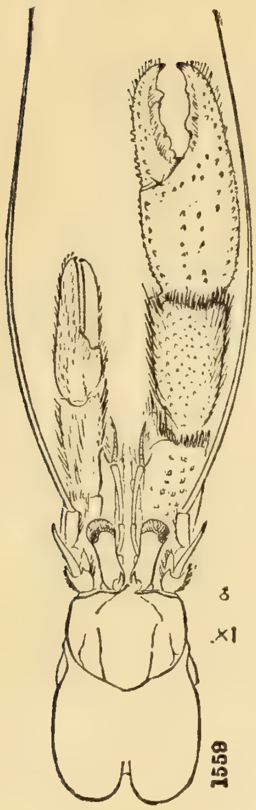

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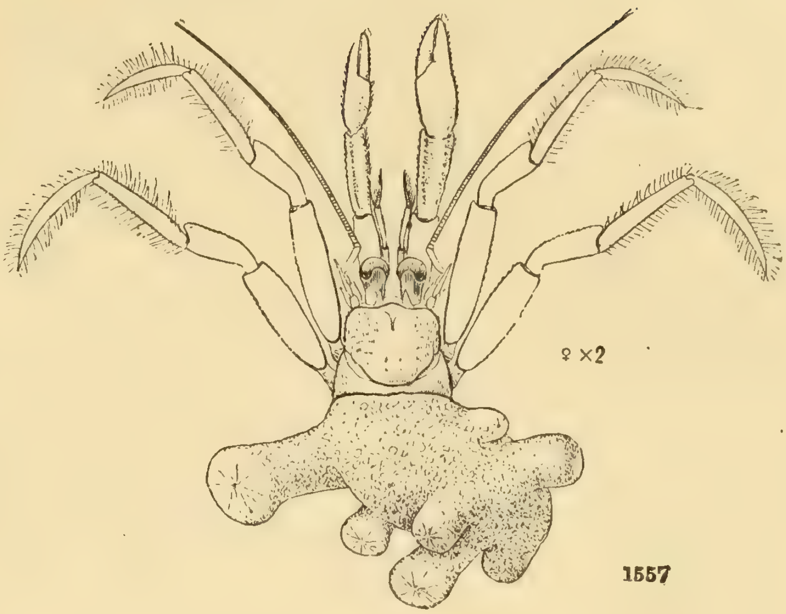

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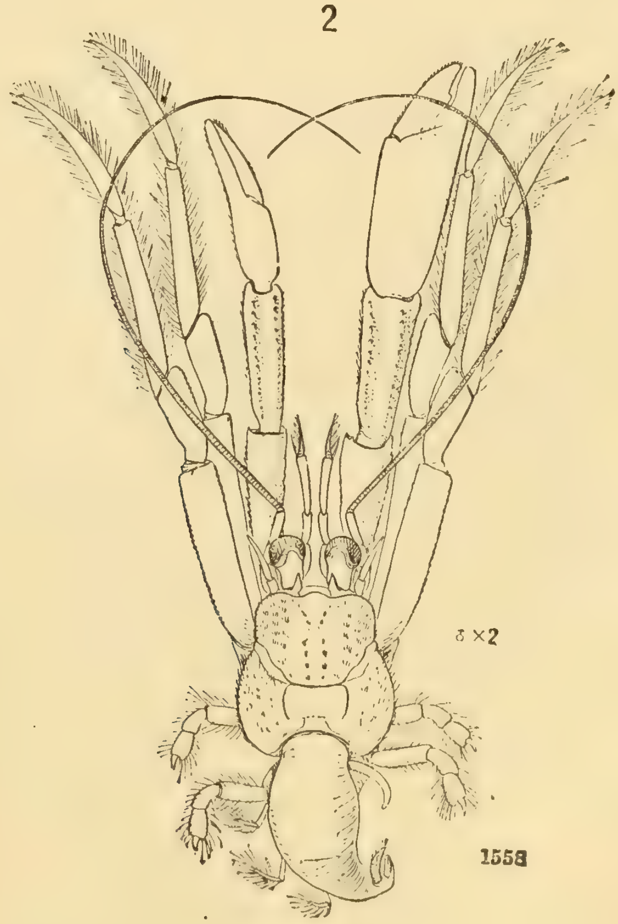

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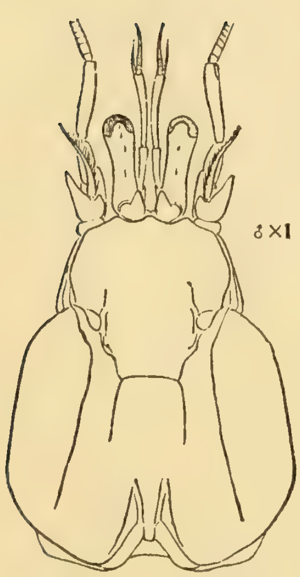

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1560

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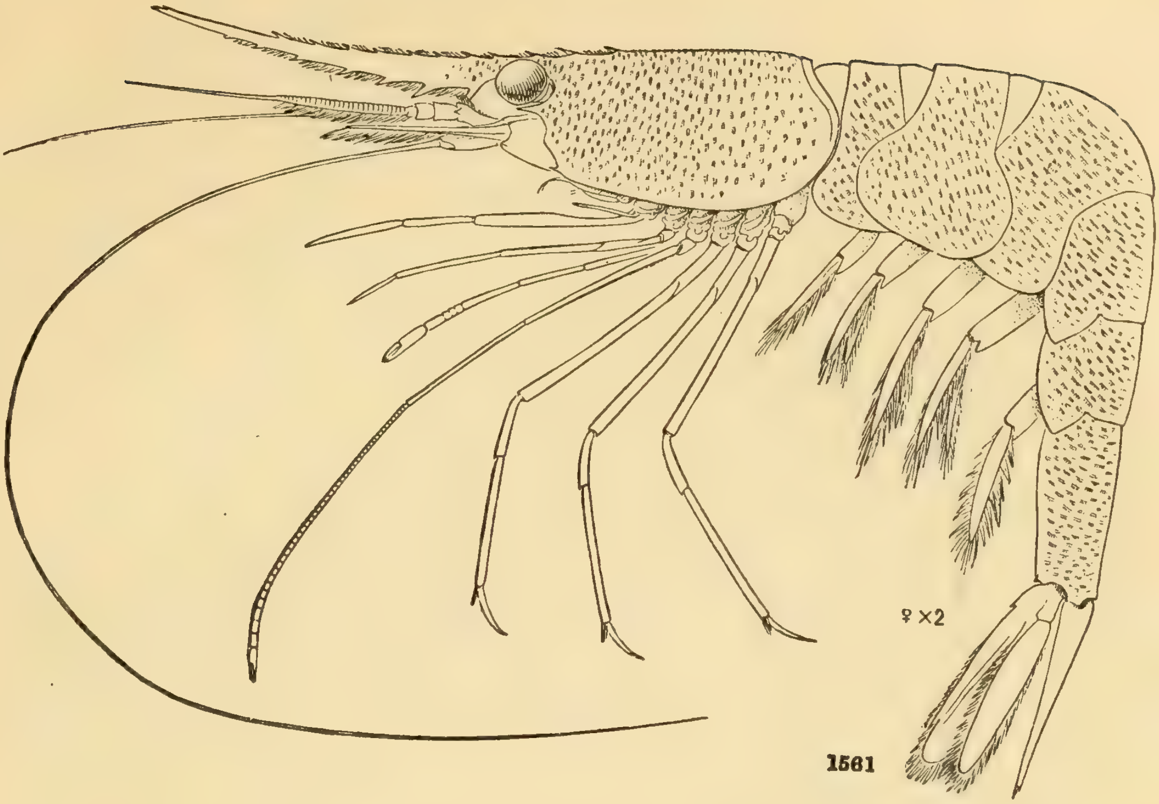

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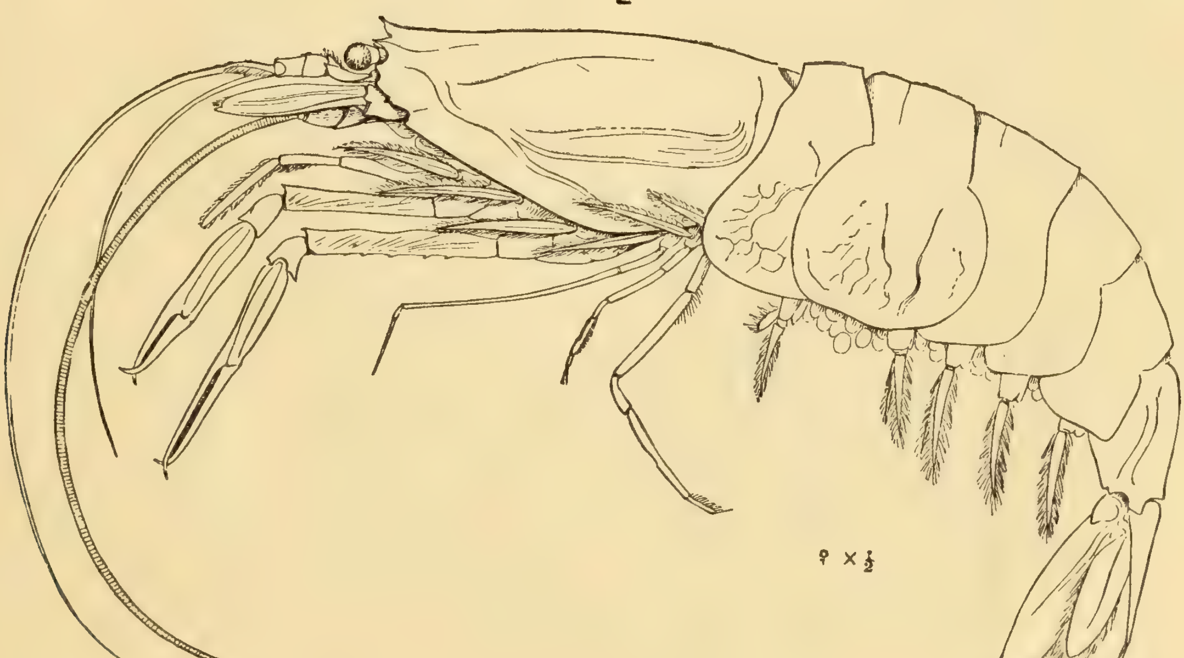

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1563

4

♀ ×1

1564

PLATE VI.

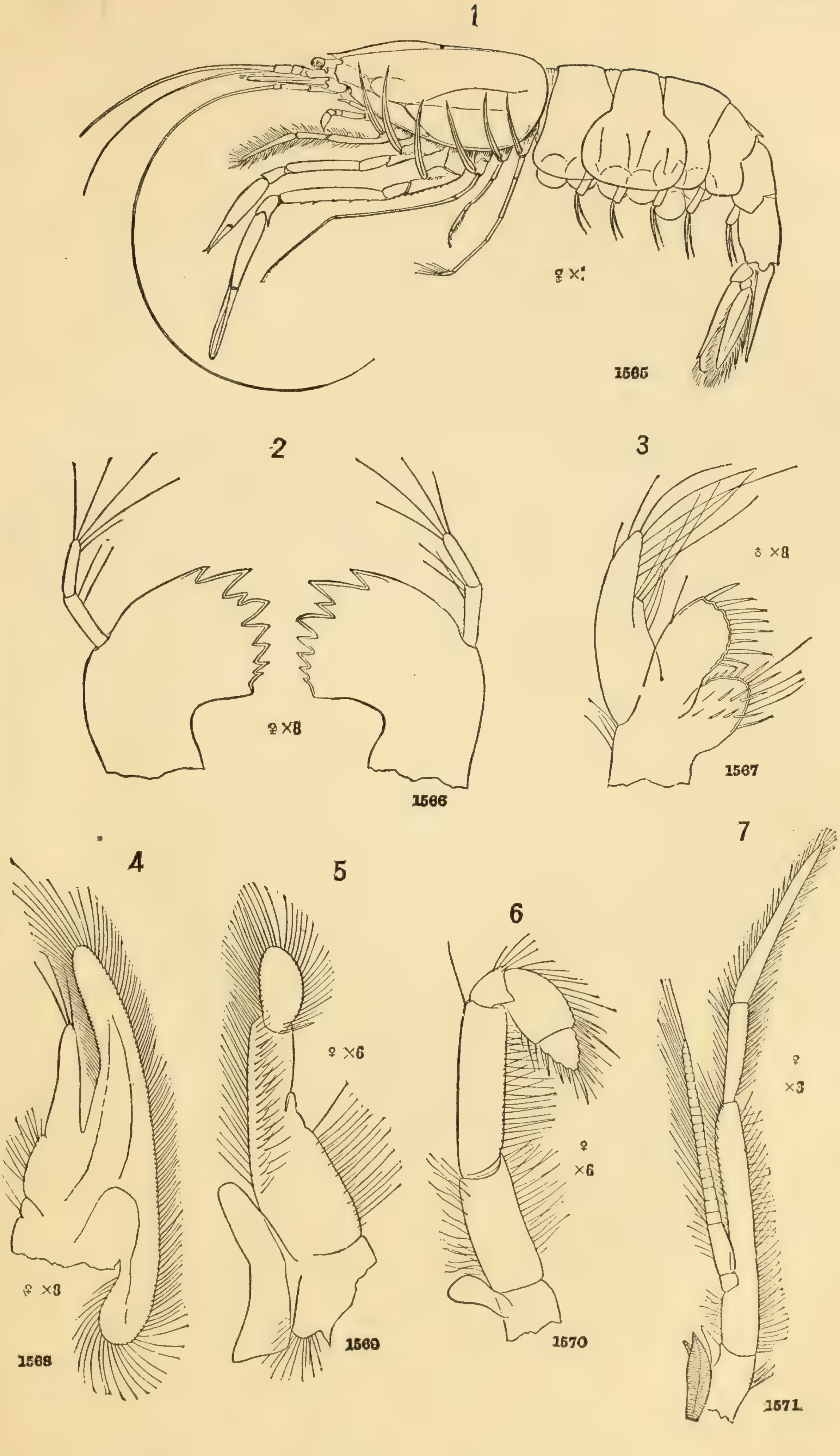

PLATE VII.

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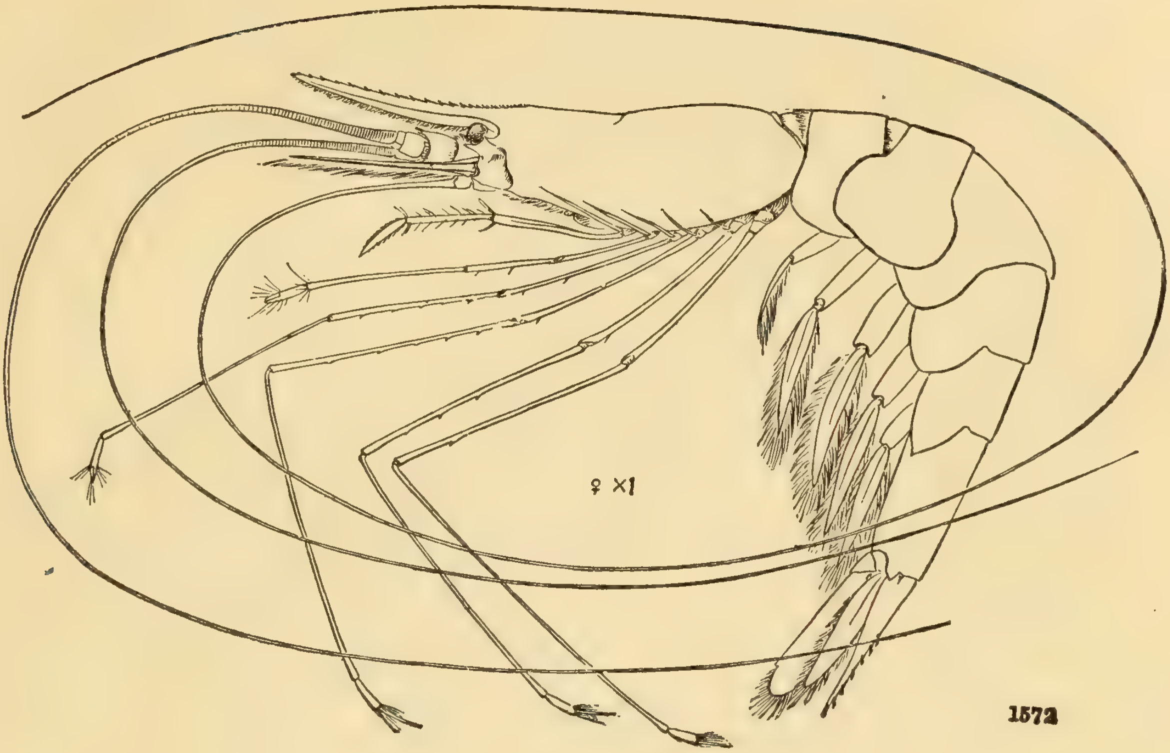

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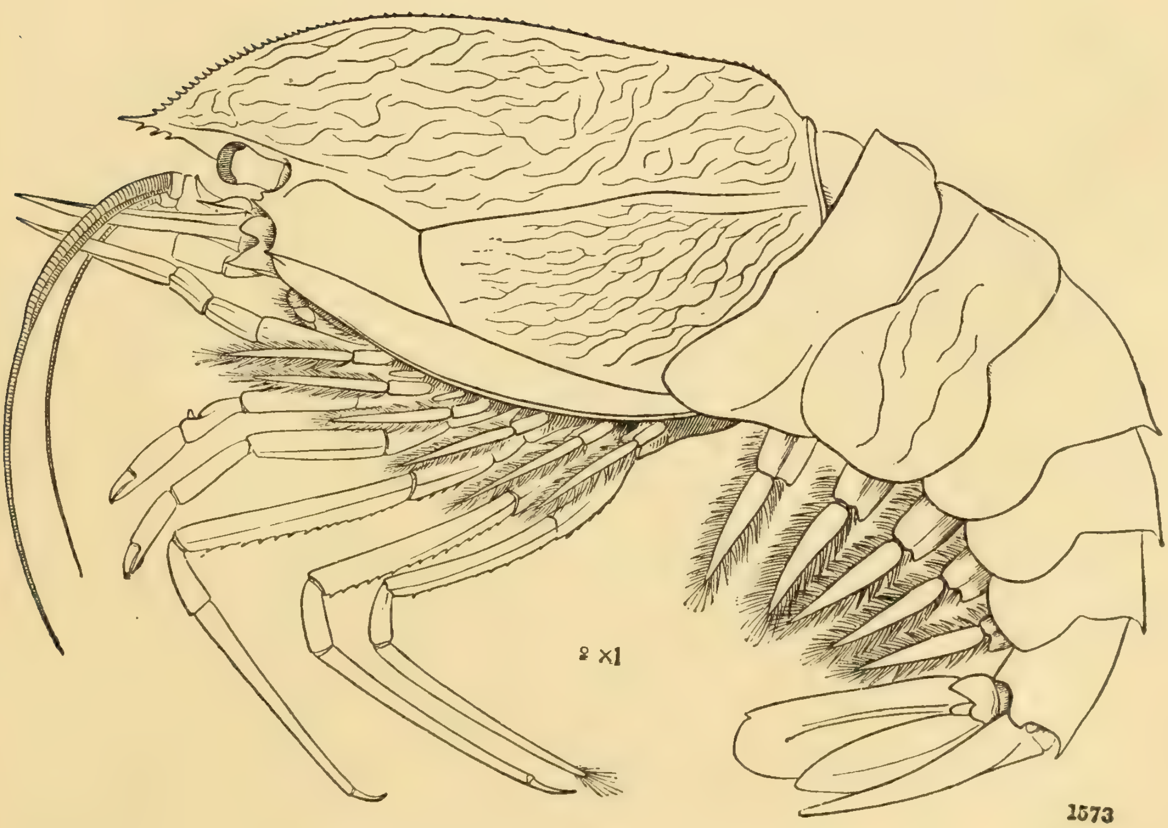

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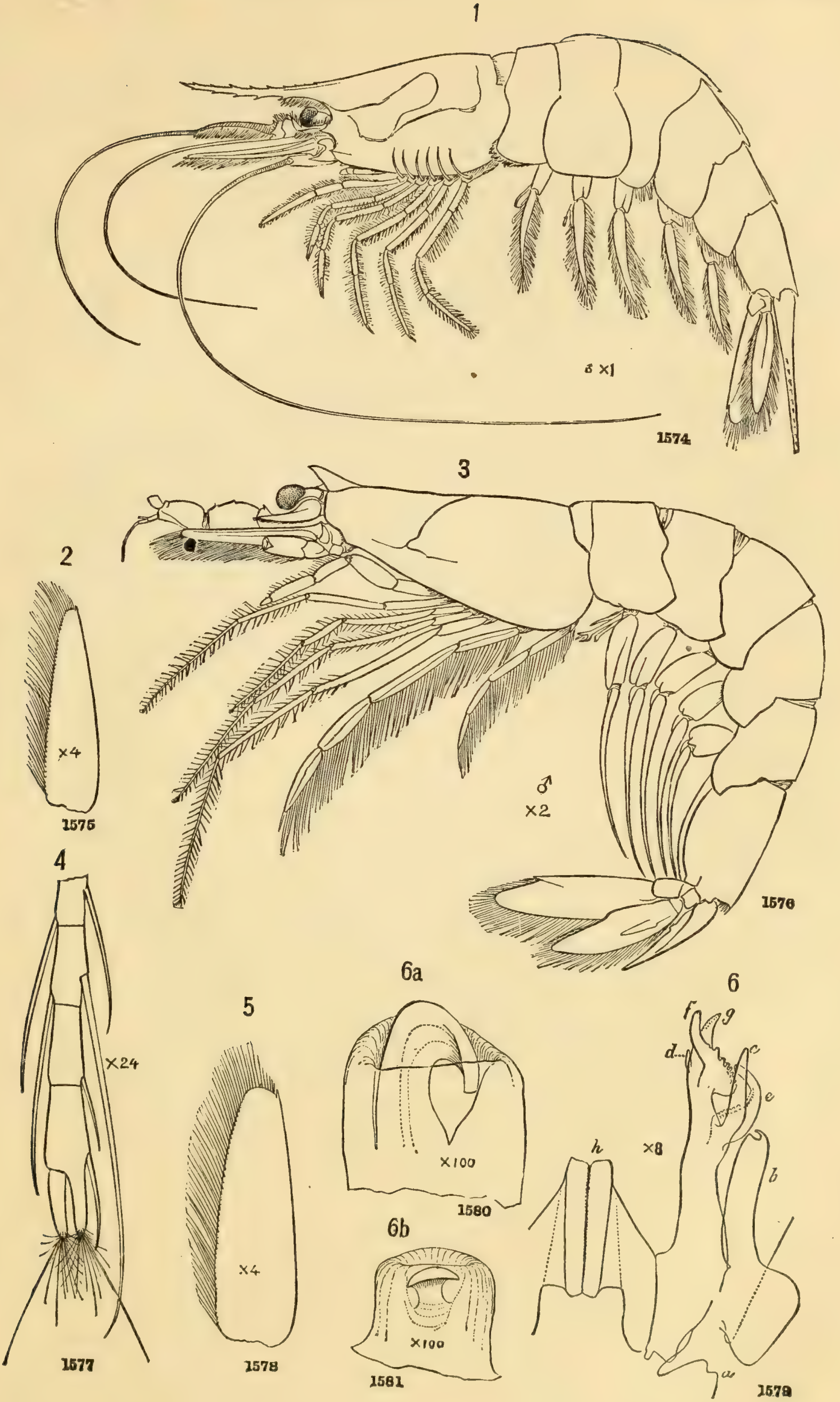
PLATE VIII.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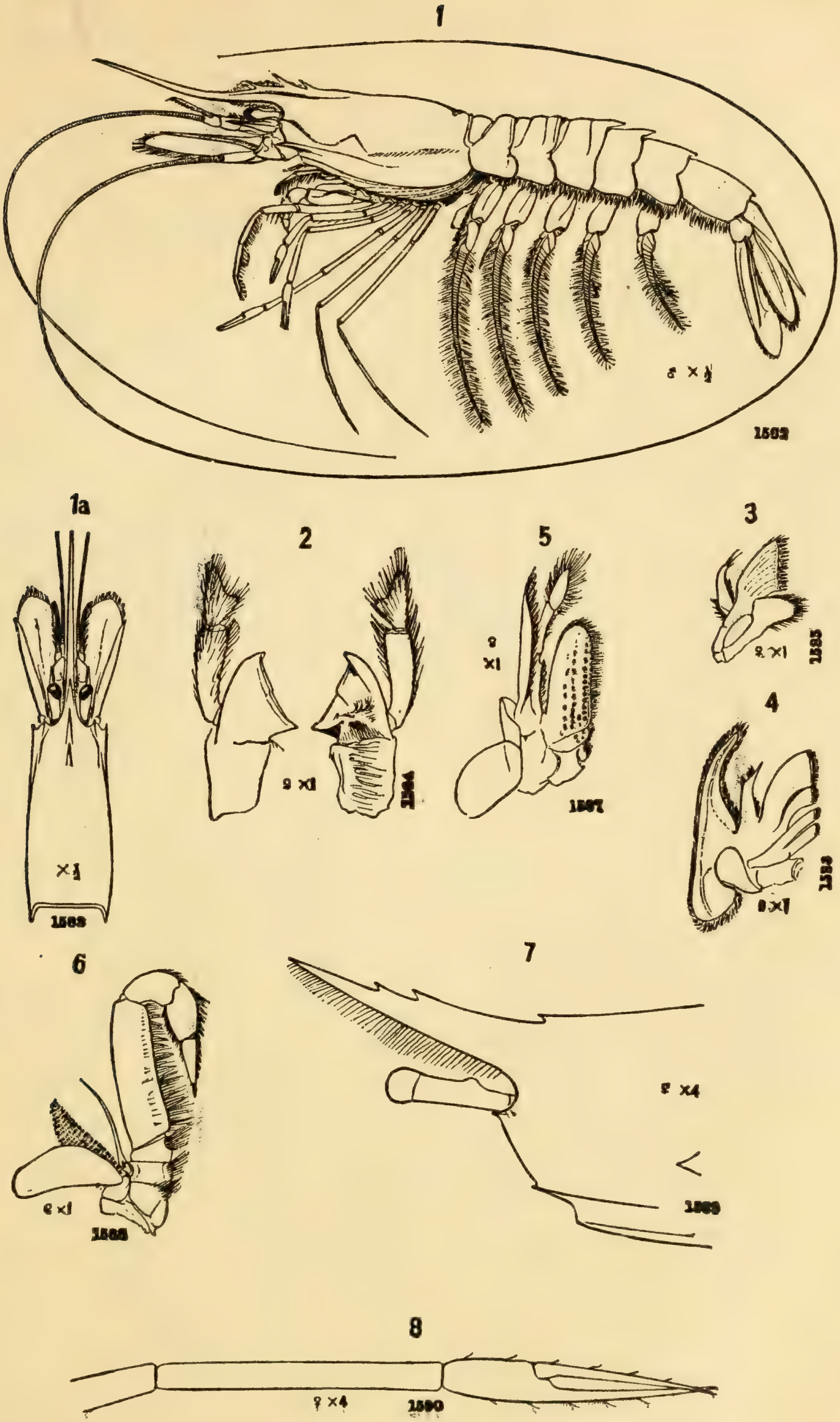
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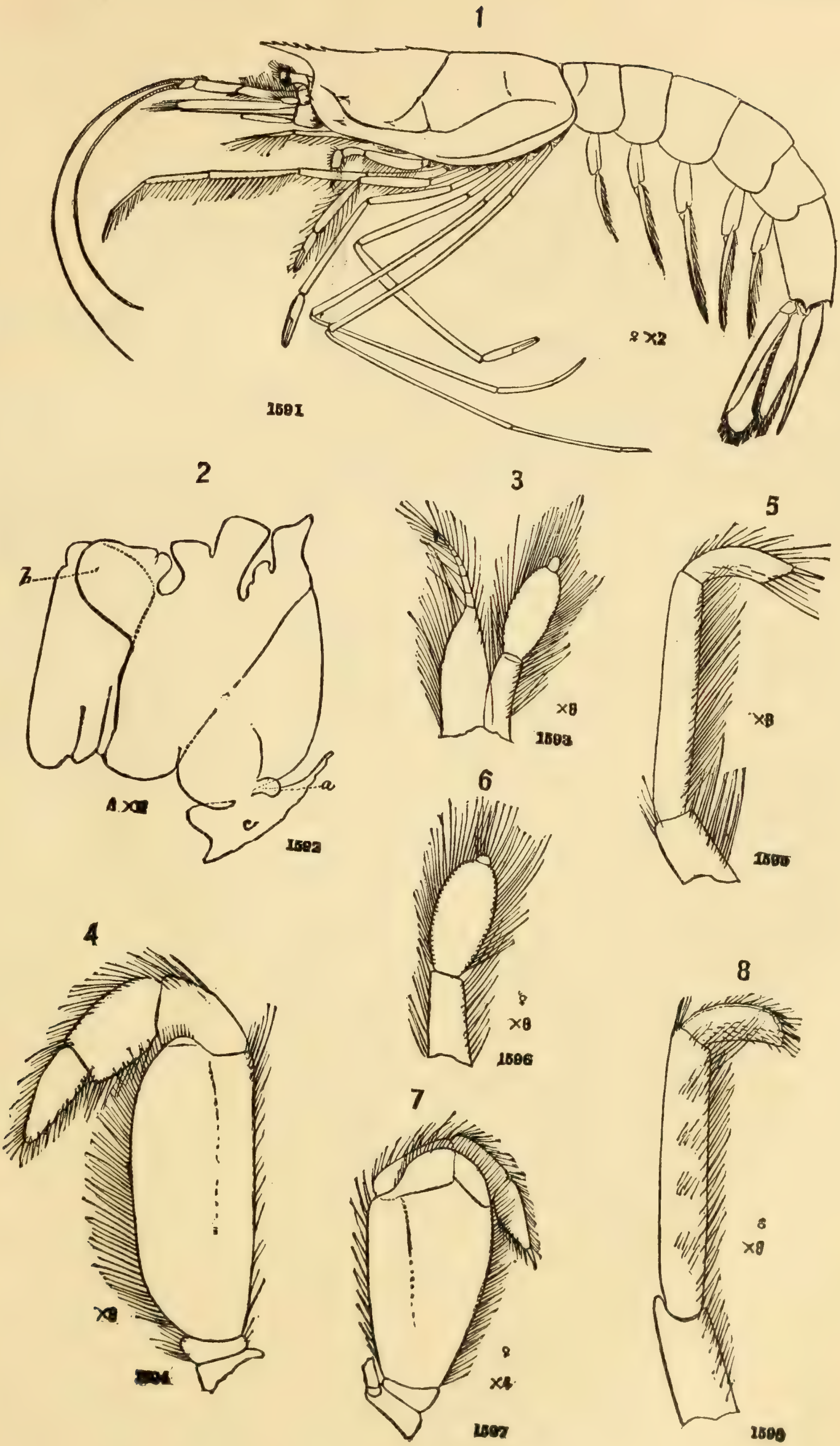
PLATE X.



INDEX.

NOTE.—The references are to page-figures in brackets.

XVI.—ON THE OCCURRENCE AND QUANTITY OF THE EGGS OF SOME OF THE FISH OF THE BALTIC, ESPECIALLY THOSE OF THE PLAICE (PLATESSA PLATESSA), THE FLOUNDER (PLATESSA VULGARIS), AND THE COD (GADUS MORRHUA).*

By V. Hensen.

[From the Fourth Report o the Commission for the Investigation of the German Seas. Berlin, 1883.]

By orders of the Commission I have, for four years, endeavored to make observations regarding the spawn of the above-mentioned fish. As regards the spawning of the cod on the coasts of Norway, we are well informed by Mr. G. O. Sars'† admirable observations; and as regards this fish the only problem to be solved was whether the spawning of the Baltic cod took place in the same manner. The same, however, cannot be said relative to the plaice (*Platessa platessa*). A circular of inquiry, addressed by the Royal Government of Schleswig to the different fishery associations, elicited the most contradictory statements, even as regards the time of spawning, and it became evident that not a single one of the numerous answers showed a knowledge of the actual condition of the eggs after spawning.

In going over the literature on the subject, we find that Alex. Agassiz‡ has seen floating eggs of the plaice, of which he gives a drawing; and that Malm § has artificially impregnated eggs of the plaice, without, however, succeeding in hatching young fish. According to Malm, the eggs slowly sink to the bottom. Only at a late stage in the course of my investigations was my attention directed by Professor Metzger to Malm's observations. This fact probably has been the cause of reaching my conclusions somewhat later than would otherwise have been the case.

The eggs of the plaice are, like those of the cod, transparent, have a

* "*Ueber das Vorkommen und die Menge der Eier einiger Ostseefische, insbesondere derjenigen der Scholle* (*Platessa platessa*), *der Flunder* (*Platessa vulgaris*), *und des Dorsches* (*Gadus morrhua*)." Translated from the German by Herman Jacobson.

† *Indberetninger til Departementet for det Indre, angaaende Torskefiskeriet i Lofoden*," Christiania, 1869.—English translation in Report of U. S. Fish Commission, 1877. Sars' work is one of the greatest achievements in this field of scientific investigation.

‡ Alex. Agassiz: "Proceedings of the American Academy of Arts and Sciences," Vols. XIV and XVII, on the young stages of osseous fishes, II and III.

§ A. W. Malm: "*Bidrag till Kännedom af Pleuronektidernes utveckling.*" *Svenska Vetenskaps Akad. Handlinger*, Vol. VII, 1867 and 1868.

thin shell, and do not contain drops of fat. The shell of the egg, under a powerful magnifying glass, has the appearance of fine wavy fibers, crossing each other irregularly. There are, however, no real fibers, but they are simply thicker portions of the egg shell. These thick places vary greatly in different eggs; in some they are not found at all, but in that case the porous channels appear very distinctly as numerous delicate dots. In my opinion, this fibrous appearance is caused by a shrinking of the contents of the egg, which gives less tension to the egg shell, but does not hinder the development of the egg. The mature eggs are not sticky. The eggs of the plaice are large, and those of the flounder small; but the smallest of all (less than one millimeter) are those of the *Platessa limanda*. I have not been able to observe any difference between the eggs of the cod and of the plaice, excepting in the outer structure of the shell, unless it be that in the egg of the plaice there is by the side of the micropyle a dot, almost resembling a second micropyle, which I did not see in the eggs of the cod. Impregnated eggs, which have not yet developed, can only be distinguished from other eggs, with the naked eye, by the circumstance that the yolk of the cod egg is decidedly yellowish, whilst in the plaice egg it is colorless.

When I received the first specimens of mature female plaice their developed eggs, when placed in water, sank to the bottom. Judging from this observation it seemed possible that the eggs were piled up in holes in the bottom or laid in nests, or that the fish simply scattered their eggs on the bottom. The first question, therefore, was to find the place where the fish deposited their spawn. I was informed that in March (the spawning season of the plaice and flounder being in March and April, and that of *Platessa limanda* in May) plaice had occasionally been found lying close to the side of each other on the coast near Friedrichsort (bay of Kiel), just as if they had gathered in certain places for the purpose of spawning.

Young plaice are, in autumn, found in great numbers among the seaweed, and in shallow places near the coast. I have found them particularly near Eckrenförde; but similar reports have also reached me from Flensburg and from Stein on the bay of Kiel. In summer Professor Möbius has also caught young fish floating about freely in the inner bay of Kiel; but we have not yet succeeded in catching very young fish. Therefore, it seemed proper to commence the investigation by endeavoring to obtain some of these fish.

For a number of years but very few plaice have been caught in the inner part of the bay of Kiel. Only in 1882, when the saltness of the water was unusually marked, and when a number of marine animals from the North Sea—otherwise not found in these waters—had made their appearance, and then but temporarily, did the plaice fisheries flourish in the inner bay. For this reason the attempt to catch young fish had to be made near the mouth of the bay. I could not take part in these experiments, and the fishermen whom I had engaged for the purpose only

succeeded on the 14th of May in getting a few specimens of young fish. These had already lost their symmetrical shape, and measured about 12 centimeters in length. They had been found among the algæ a short distance beyond the mouth of the bay. If nothing else was gained, we had at any rate discovered a place where search for such fish might be made.

The experiments in developing eggs did not succeed. The vessels in which I had placed them were attached to poles and sunk in the bay, but the motion of the waves had thrown the eggs too violently against the sides of the vessels, and from this cause probably they had perished.

Therefore, the following year it was our purpose to obtain the eggs which might be freely scattered over the bottom. The eggs will slip through the meshes of a common dredge, and by a net with narrow meshes the bottom cannot be sufficiently scoured, because the net will be filled with particles of mud from the bottom as soon as it becomes the least embedded in the ground, or is dragged over a soft bottom. It is important that the eggs should, if possible, be obtained by small quantities at a time. For this purpose we used the contrivance shown in the accompanying illustration.

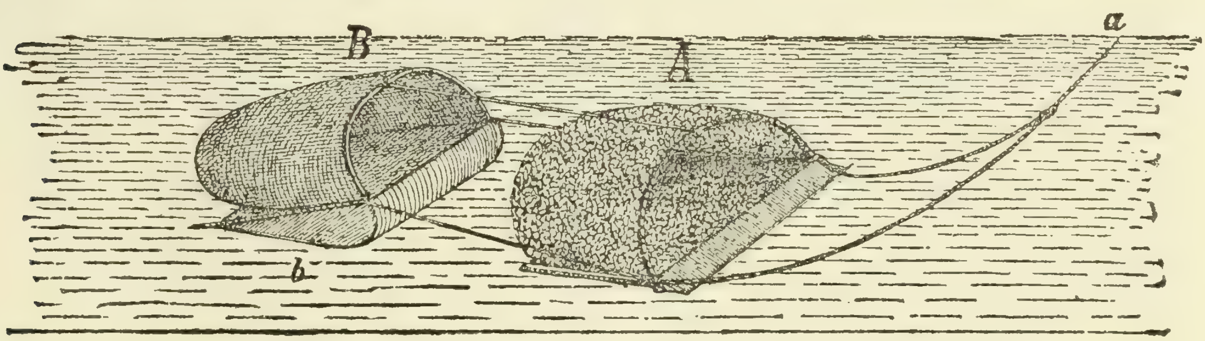


FIG. 1.—Dredges for collecting fish eggs.

At the distance of about a foot from the bag of a common dredge (A), a second light dredge with very narrow meshes (B) is fastened to the first by three cords; it rests on a bent piece of thin tin (*b*), in such a manner that the opening of the net is entirely raised from the bottom, and does not touch it at all. Any light objects stirred up from the bottom by the preceding dredge, if small enough to pass through its meshes, are caught by the tight bag of the second net, whilst heavy objects, such as sand and small stones, fall to the ground before the opening of the second net. This contrivance has been found exceedingly practical in fishing lower forms of animals.

In 1881 only dead eggs were caught in the inner bay, which probably came from the numerous plaice and cod caught during that year.

It was not until we reached buoy No. 1, outside the mouth of the bay, at a distance of 18 kilometers from the city of Kiel, that at every haul, going to a depth of 18 and less meters, we caught, close to the deep channel of the Kiel bay, which begins here, a number of eggs which floated about freely and did not adhere to any objects. Sometimes we found them singly, and occasionally in clusters of 30 to 50. From this circumstance we concluded that these eggs, which first were found on

the 23d of April, and for the last time on the 11th of May, were scattered freely over the bottom and did not adhere to any objects.

We found large and small eggs of different kinds mixed. Some of the small eggs, having a diameter of about 0.93 millimeter, contained in their inside a yellow or yellowish-brown drop of fat; but we also found some larger eggs, measuring as much as 1.3 millimeters in diameter, seemingly of the same kind, and probably belonging to a species closely related to the former. Occasionally we found in these eggs several drops of fat instead of one. Other eggs, as to their size, homogeneity of contents, fibrous appearance of the shell, and colorless appearance of the yolk, strongly resembled the eggs of the plaice. We finally found small colorless eggs, without fat, measuring 1.15–1.27 millimeters, which proved to be eggs of the flounder. As I ascertained at a later date, similar eggs, having a diameter of 0.85 and 0.9 millimeter, and the considerable specific gravity of 1.020, are found in May; these are the eggs of *Platessa limanda*.

At the same time that we investigated the bottom, which only yielded any result outside of the bay, we scoured the surface. During the same period we here found two kinds of eggs, one with yellow drops of fat, not distinguishable from the larger eggs of the same kind found at the bottom, and a second kind, having a diameter of 1.24 millimeters, and without drops of fat, but characterized by the circumstance that the yolk appeared broken by even planes crossing each other almost at right angles.

These different eggs were hatched, with the following results: From the two kinds of eggs containing drops of fat there slipped small fish having a deep black pigment, and measuring at most 2.43 millimeters in length. The large yolk-bladder projected somewhat beyond the head, the eyes were pigmentous, the sphincter was close to the yolk-bag, and the chorda consisted of several rays.

The young plaice, after slipping out of the egg, remained alive 11 days. Their eyes showed some pigment. The length of the body was 5.26 millimeters. The yolk-bag was large, and the sphincter close to it. The chorda cells consisted of several links; the arch of the gills and the lower jaw were not yet developed. The young fish hatched from the flounder eggs were but little developed. Their eyes showed no trace of pigment; their length was about 3.6 millimeters. The sphincter, lying close to the yolk, was connected with the intestinal canal only by a thin cord, and the chorda had several rays. From the eggs whose yolks appeared broken there came narrow fish 3.7 millimeters in length. They were not much developed; their eyes had no pigment; they distinguished themselves from the young fish mentioned before by the construction of the chorda, which had only one ray, and also by the circumstance that the sphincter is not close to the yolk, but opens very far back, and only about 0.5 millimeter from the tip end of the tail. In this particular as well as in their form and shape, after the yolk had been absorbed, these

fish closely resembled the herring. The intestinal canal, back of the stomach, however, takes a somewhat different and more crooked course. They also somewhat resemble the small fish called by Agassiz *Osmerus mordax*. Nothing is said, however, about the construction of the chorda in this last-mentioned fish. Both the herring and the *Osmerus* have bubbly yolk, and therefore differ very noticeably from the fish observed by me. In 1882 I caught large numbers of eggs, whose yolks had a broken appearance, near the Dänenkathe, opposite Friedrichsort, and between Jägersberg and Korügen, therefore near the mouth of the bay. All the fish mentioned so far did not have red blood, prior to the absorption of the yolk.

Other eggs observed by me were those of the *Cottus scorpio*, which adhered to piles in the bay in large numbers (during January to April), and of *Cyclopterus lumpus* (April). These last-mentioned eggs Professor Mobius obtained from Eckernforde, where they were found adhering to a pile in such a large lump as to render it improbable that they were laid by one fish. The eggs of the *Cottus* showed numerous protuberances and measured 1.4 millimeters, whilst the young fish measured 5.4 millimeters. The eggs of both these fish contain drops of fat, which, especially in those of the *Cyclopterus*, are very large and almost colorless. The young of both these kinds of fish, when leaving the egg, show a complete circulation of red blood, and are exceedingly lively and well developed. The *Cottus* forms a beautiful object under the microscope, whilst the *Cyclopterus* is opaque, with a thick-set body and a small tail. The suction disk makes its appearance a few days after the fish are hatched, and is put to frequent use. The protuberances on the head and dorsal fin do not develop until the yolk has been absorbed. Numerous older specimens of *Cyclopterus* were, in May, found among the sea-weeds outside of the bay. In both these fish the chorda has several rays, and the sphincter is close to the yolk. The only fish whose sphincter was midway between the yolk and the end of the tail (similar to the *Ctenolabrus cæruleus** according to Agassiz) was a small *Gobius*, whose eggs were found adhering to sea-weeds.

The object in view, to find spawn of the plaice and the flounder discharged in a natural way, seemed to be attained. The eggs were found scattered and lying loosely on the bottom in deep places of the sea near the coast, in places where plaice fisheries were carried on. This agreed with Malm's statement, that the impregnated eggs gradually sink to the bottom, but not with Agassiz's statement, that he had found eggs of flat-fish (*Pseudorhombus oblongus* Stein) floating about near the surface. Strictly speaking, the object in view could only be considered as attained so far as the year 1881 was concerned, as became evident later.

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* *C. Sundewall:* "Om Fiskyngels utveckling." Kgl. Svenska Vetensk. Akad. Handlinger, N. F., Vol. I, 1855, gives drawings of young fresh-water fish, according to which the sphincter occupies a position in the middle in *Perca, Esox* (very far back), *Cyprinus rutilus* and *idus*.

It seemed very surprising that no floating cod eggs had been found, although at that period some of these fish had not finished spawning. When I took some cod-eggs and impregnated them, it appeared that they did not float either, but sank to the bottom like the eggs of the plaice.

This discovery made new investigations necessary, but these could not be made till the spring of 1882. I impregnated the eggs of cod, plaice, and flounder; and by keeping, by means of ice, the temperature of the water at 4°—8° Celsius, and by keeping the water in motion through a glass funnel drawn up and down, I succeeded in hatching a number of young fish. At some future time I intend to give a full report of their development; and so I will only state here that plaice and cod were hatched in about fourteen days and flounders in eight days. My diagnosis of the previous year was, therefore, entirely confirmed. It appeared, however, that the capacity of the eggs of these three kinds of fish for floating in the water is limited and varies very much. Inconsiderable fluctuations in the saltness of the water are sufficient to cause the fresh-laid eggs either to rise or sink. Moreover, when the saltness of the water is not very great, many impregnated and developed eggs sink to the bottom after a short time; whilst *all* eggs which have either not become impregnated, or which have ultimately died, always sink to the bottom.

The way the eggs would act could not be stated beforehand with such certainty as people will be inclined to suppose. There was no fact to indicate that the capacity for floating of the eggs, which frequently contained a great deal of oil, was very small, and adapted itself so little to external conditions. As matters stood, a more thorough examination of this subject appeared to be of practical and scientific interest. I therefore deem it proper to give exhaustive statements relative to the weight and number of the eggs—statements which for the present may appear, perhaps, too detailed.

*R. E. Earll** has given us an excellent treatise containing full data relative to the cod, the plaice, and the *Gadus pollachius*. From his experiments in impregnating fish-eggs it appears that invariably only a certain quota of the total number of eggs contained in a fish could be successfully preserved. Thus, for instance, of a fish containing 2,700,000 eggs, only 400,000 eggs, or one-seventh of the entire quantity, could be preserved; the remainder matured later and were discharged in the hollow of the ovarium. Earll comes to the conclusion that, in such a fish, about 337,500 eggs matured per week, and that its spawning period lasts two months. He also shows that all fish ultimately discharge all their eggs. The mature eggs of a cod weighing 75 pounds would weigh about 45 pounds; and it is impossible that any fish could at one and the same time contain this quantity.

I have no objection to these important observations, as all my ob-

* United States Commission, Fish and Fisheries. Report of the Commissioner, 1878. Part VI, p. 685.

servations tend to confirm them; but I must state that, according to my observations, the eggs in the ovarium show five very distinct stages: (1) free, (2) mature, (3) clear, (4) large muddy, and (5) small muddy eggs. Even in the immature ovarium three distinct stages can be distinguished, and this whole matter will have to be studied more closely.

Earll ascertained the number of eggs by weighing first the entire ovarium, then pieces of it, and by counting the number of eggs in some of these. This proceeding may be considered as leading to reliable results, as, according to my observations, the character of the ovarium is very much the same in its different parts, and as it would almost be impossible to count the eggs in any other way. It is, of course, possible that some of the small eggs do not reach maturity, but are, especially towards the end of the period, again absorbed. My observations relative to this matter, however, have, so far at least, only yielded a negative result.

Earll makes the following calculations:

	Eggs.
Cod, 75* pounds, 9,000,000 eggs, per 500 grams	160, 750
Cod, 51 pounds, 8,489,094 eggs, per 500 grams	236, 150
Cod, 30 pounds, 3,715,687 eggs, per 500 grams	165, 950
Cod, 27 pounds, 4,095,000 eggs, per 500 grams	203, 200
Cod, 22¾ pounds, 3,229,388 eggs, per 500 grams	190, 200
Cod, 21 pounds, 2,732,237 eggs, per 500 grams	174, 300
Average	188, 425
Plaice, 9 9/16 pounds	1, 834, 581
Plaice, 6 3/16 pounds	849, 315
Plaice, 4 pounds	403, 132
Plaice, 3 3/16 pounds	298, 976
Gadus pollachius, 23½ pounds	4, 029, 200
Gadus pollachius, 13 pounds	2, 769, 753

The following are the dimensions of the eggs: Those of the largest cod 1.5 millimeters, and those of the smallest cod 1.34 millimeters in diameter; *Gadus pollachius*, 1 millimeter. No measurement is given of the plaice. The specific gravity is given as varying between 1.020 and 1.025; but I presume that this is only an estimate based on the specific gravity of the sea, for otherwise these figures would be very remarkable.

The period consumed in hatching the eggs of the cod was: At 7.5° C., 13 days; 5° C., 16 days; at 3° C., 20 days; at 2.2° C., 24 days; at 0.5° C., 34 days;—1.2° C., 50 days; when the temperature is lower the eggs perish. Some eggs develop the young fish slower; those fish which are hatched first and last are not very strong.

With a view to distinguishing with greater certainty the eggs of dif-

* This seems to be Troy weight, therefore only 373.2 grams per pound.

ferent species, and to comparing them with each other, I have endeavored to obtain average figures relative to the measurements, but in doing this I encountered innumerable difficulties. By measuring eggs which had not yet been impregnated, I found that as a rule they are ellipsoids, and not globes. In measuring such eggs, it is not absolutely certain whether one measures the long or short axis. Moreover it is necessary to measure a considerable number of free eggs, which is a very tiresome process. It would be better if the average diameter could be gained from the weight, numbers, and specific gravity; but the exceedingly tender nature of the eggs became an insurmountable obstacle when I attempted to measure in this manner eggs which had not yet been impregnated.

The freshly laid eggs lie in a liquid which may well be designated as *Liquor folliculi*, as it probably originates in Graf's follicles. This liquid has less specific gravity than the eggs, and has, therefore, to be examined separately. As the shell of fresh eggs when exposed to the air is very apt to burst, partly through the weight of the eggs, no method could be found to weigh the eggs in a dry condition. The liquid would have to be removed by washing the eggs, which would cause them to swell and possibly produce transudation, thus changing the original character of the eggs. The eggs, after having been laid in salt water undergo very considerable changes. After a while they become so hard that they can be rolled between the fingers, and their presence among other matter brought up from the water can easily be ascertained by the touch. Eggs which have not been impregnated do not become so hard, because after awhile they begin to dissolve. For 14 days, however, and even longer, their shape remains well preserved, and, compared with fresh eggs, they seem hard. The hardening process, in order to become perfect, requires one day. But I have not followed this process closely, and must mention this circumstance because afterwards my attention was directed to a very striking observation made by Mr. Earll. He says, on page 721:

"It was found desirable to leave the eggs for fully half an hour together with the milt; and sometimes a longer time was required to make them quite hard."

Earll, therefore, seems to assume, as a well known fact, that fish-eggs harden in consequence of impregnation. If there are any facts relative to this subject in literature, they must have escaped me. Hitherto I have considered the hardening process as owing to the effect of the water, and the gases contained in it; which is undoubtedly correct as regards the hard crust found on many eggs. If impregnation by itself cause a hardening of the eggs, this must be considered as a fact not yet sufficiently noted and examined by science.

As regards eggs which had not yet been impregnated I have, in the following manner, endeavored to obtain approximately correct data: I first determined the specific gravity of the liquid, then that of the eggs in the liquid. Thereupon the weight of a certain known number of eggs

with liquid in air. Finally I measured the eggs of the same fish, and from all these observations I determined their true weight and their specific gravity.

The mature eggs of three female cod each weighing 1½ pound, were placed on filters, in order to obtain the liquid. It is advisable for this purpose to remove the ovary from the fish, to open them, and let the eggs run out into a vessel. In this manner more eggs, and generally ones in a better condition, are obtained than by squeezing them out, which process is also apt to let other secretions mingle with the eggs.

The specific gravity of this liquid, as determined by the picknometer, was 1.01115, at a temperature of 8.7° C. The specific gravity of a quantity of eggs, with liquid, of the same fish was 1.01542, at a temperature of 7.2° C. Nine hundred and sixty-one of these eggs weighed 1.9038 grams.

To find the relative quantity of the liquid, the diameter of these eggs had to be ascertained. In order to avoid their pressing against each other, they were placed in the remainder of the filtered liquid, and after 23 measurements the maximum diameter was found to be 1.4119 millimeters, the maximum 1.5099, and the average 1.4375. The average volume of an egg $\left(\frac{\pi}{6}d^3 = \text{vol.}\right) = 0.5236$ multiplied by $2.9705 =$ 1.5553 cubic millimeters. The above mentioned 961 eggs, therefore, had a volume of 1494.6433 cubic millimeters.

As the specific gravity of the eggs with the liquid had been 1.01542, the volume of the above 1.9038 grams eggs with liquid was 1.9038 divided by $1.01542 = 1.8749$ c. c.; subtract from this the volume of the 961 eggs, which is 1.4946, and the volume of their liquid is 0.3803 c. c.

Calculating the percentage on the quantity of eggs in these three fish, we find, that of the total quantity of matter discharged from the ovaria 79.72 per cent. was egg substance and 20.28 liquid.

As this mixture had a specific gravity of 1.01542, and the liquid a specific gravity of only 1.01115, the specific gravity of the eggs, at a temperature of 8.3° C., is found to be 1.01664. The equation from which this result is obtained would be the following (x standing for the specific weight of the eggs):

$$79.72x + 20.28 \times 1.01115 = 100 \times 1.01542.$$

It must be observed, however, that small differences in the micrometric measurement change the results considerably. Careful measurements of 23 eggs, from a cod weighing 9 pounds, showed the large diameter to be 1.502, and the small diameter 1.457 millimeters. Calculated from these figures the volume of the ellipsoid was found to be 1.6703 cubic millimeters, and from this, the average diameter of the globe of the egg 1.4721 millimeters. If I use this diameter for the above calculation I find per 100 volumes eggs 85.61 per cent. egg substance and 14.36 per cent. liquid. The specific gravity of the eggs by themselves, is, therefore, 1.016165. The fourth decimal, therefore, shows already differences. Other experiments show that the quantity of liquid is not always the same; but the above mentioned 20 per cent. is probably to

be considered as a large percentage. If, in order to test the matter, we suppose that there is enough liquid between the globes of the eggs, to allow them to fill the space, without pressing against each other, it follows that every egg having a radius = 1 must lie in a dodecahedron, whose half height h would be =1.6343, whose basis at the plane of this half would be 5.1955 square meters (g), whose hollow space would therefore, be—

$$\left(\frac{v={}^2gh}{3}\right)=5.678 \text{ cub.}$$

whilst the globe r would be=1=4.186 cub.

so that the quantity of liquid in the mass of eggs would be=1.489 cub.

This would be 26.21 per cent. liquid. As the eggs actually pressed against each other, and as no liquid gathers on the top of them, the percentage of liquid must be less that 26.21; and the actual quantity of liquid would be between 14 and 20 per cent., but it is certain that the percentage of liquid varies greatly. The liquid acts as a strong alkaline reagent, and contains an albuminous substance, which can be obtained by boiling and by acetic acid, and which, when precipitated by alcohol, cannot be dissolved again.

Eggs which had not been impregnated, when thrown in salt water, float near the surface, the specific gravity being 1.0156 and the temperature 5.3° C., and the specific gravity being 1.0141, the temperature 17.5°, and the saltness 1.85 per cent.; they begin to sink at a specific gravity of 1.0146 and 5.3° C. = 1.0131 specific gravity at 17.5° = 1.72 per cent. saltness. Of the impregnated eggs one-half float near the surface at a specific gravity of 1.0155, at 7.04° C. = 1.0145 at 17.5° C. = 1.90 per cent. saltness. Probably, however, these eggs were still covered with spawn to a considerable extent, for in the open sea they floated near the surface at a less specific gravity. When the eggs are impregnated in a thin solution of salt, and are then examined as to their capacity for floating, they do not appear noticeably lighter than when they are immediately thrown in a concentrated solution. At least the difference is very small.

As in liquid the eggs have a specific gravity of at least 1.0161 at 8.7° C., but in salt water of 1.0155 at 7.4° C., it seems that in the latter they absorb some of the water which does not contain much salt. For practical purposes, however, it is sufficient to know that in order to keep the eggs afloat near the surface, the percentage of salt in the water should not be less than 1.85 per cent., and should at any rate be higher than 1.72 per cent. The weight of the eggs is not entirely the same. I have not yet examined eggs which had developed more, as to their weight, which probably had changed somewhat. Cod eggs freshly laid in the water would, at a specific gravity of 1.015, weigh from 1.5 to 1.7 milligrams.

In a similar manner the eggs of the plaice (*Goldbutte*) were determined. For this purpose I selected four fish having an average weight

of 1 pound and an average length of 30 centimeters. The specific gravity of the liquid was 1.01022 at 7.5° C., and of the eggs with the liquid 1.01430. After having been weighed and counted, the weight of one egg with the liquid belonging to it was 3.363 milligrams. The average diameter of the egg, calculated from 30 measurements, was found to be as follows: long axis, 1.76163 millimeters; short axis 1.71686, the minimum, 1.608; and the maximum 1.804. The volume would, therefore, according to these figures, be 0.0027188 cubic centimeters. The mass of eggs taken from the ovarium was therefore composed of 82 parts eggs and 18 parts liquid, and the specific gravity of the eggs by themselves 1.01557 at 4°.5 C.

These eggs, when thrown into salt water had a specific gravity of 1.01496 at 6.8° C=1.0136 at 7.5°=1.78 per cent. salt. It does not admit of a doubt, that these eggs had begun to swell, for the difference of weight between the eggs from the ovary and the eggs from the water is very considerable. Taking the specific gravity of the swelled egg, calculations show its volume to be 0.003081 c. c. at 7°, it weight 3.127 millimeters, and its average diameter 1.801 millimeters; whilst calculated on the basis of the original volume of the egg, it is only 1.732 millimeters. Comparisons made between the average measure of eggs taken from the sea, and eggs taken from a fish will not lead to absolutely certain results, but if the eggs are thrown into salt-water, a comparison of those eggs which have not yet been very much developed will be tolerably exact. It is of some interest to embryolgy to know that the eggs swell, considerably, so that they increase 11 per cent. of their volume and 4 per cent. of their diameter; the shell of the eggs is so thin that their swelling cannot be 0.07 millimeters. Unfortunately I neglected to make the necessary investigation of more developed eggs, which would of course require a considerable number of eggs. It would be interesting to know whether the small fish of the Baltic have as large eggs as the great fish of the ocean.

The specific gravity is, as we know, of peculiar importance as regards the Baltic. Our monthly reports show the following data as to the saltness of the water of the Baltic, at same depth, in the Bay of Kiel near Friedrichsort:

Percentage of saltness in deep water.

Year.	February.		March.		April.		May.	
	Average.	Maximum.	Average.	Maximum.	Average.	Maximum.	Average.	Maximum.
1873	2.06	2.08	1.76	2.08	1.67	1.83	2.20	2.29
1874	2.48	2.53	2.43	2.52	2.24	2.40	1.59	1.72
1875	1.73	1.83	1.64	1.77	1.59	1.61	1.73	1.83
1876	1.90	1.94	1.93	1.99	1.90	2.02	1.57	1.85
1877	1.81	2.17	1.90	2.02	1.79	1.94	1.53	1.69
1878	1.73	1.74	1.76	1.81	1.65	1.86	1.39	1.68
1879	1.59	1.70	1.51	1.72	1.51	1.69	1.40	1.45
1880	1.82	1.91	1.81	2.10	1.56	1.83	1.47	1.40
1881	1.39	1.78	1.23	1.55	1.47	1.60	1.51	1.59
1882	2.11	2.17	2.14	2.16	2.03	2.15	1.69	1.76
1883	1.82	1.86	1.79	1.89	1.86	2.00	1.68	1.90

The saltness given in the above table relates to the quantity of salt which would be contained in a solution of cooking salt of the specific gravity found in the sea.* Our areometers, according to *Behrens* and *Jacobsen*† generally give the quantity of salt somewhat too high.

Presuming that these observations also apply to the open sea, we find that cod eggs, which require about 1.8 per cent. for floating, were during the last eleven years laid in water, which on an average was too fresh, four times in February, six times in March, and seven times in April. We also find that during the three months referred to the water was three times per month so fresh that the eggs could not float at all. For the plaice eggs, which only require 1.78 per cent. salt, the average condition of the water was too fresh, five times in March, three times in April, and ten times in May. The maximum saltness did not reach the necessary height 3 times in March, three times in April and seven times in May. In the open sea the conditions of saltness may be somewhat more favorable; but beyond the Island of Rügen, in the eastern part of the Baltic, the sea water will hardly ever possess the degree of saltness necessary for floating the eggs near the surface, unless the eggs in those waters have a different weight.

It did not seem probable that the saltness of the water would have to be taken into consideration in observing the spermatozoa composing the spawn, as so far the observations had shown that, as a general rule, ½ to 1½ per cent. of cooking salt would suffice to keep the spermatozoa in healthy motion.‡ Nevertheless it seemed necessary to investigate this matter. Strange to say it was found that the spermatozoa of the cod and the plaice were influenced very strongly by the degree of saltness of the water. Probably this whole subject is more complicated than was supposed in the beginning. The condition of the fish may have something to do with it, and the temperature may be of some importance. Observations made at a temperature of 0 to 4°, however, proved beyond doubt that mature spawn taken from the cod when not diluted, did not show any motion, whilst, when placed in sea water (taken from the aquarium) with a saltness of 1.9 per cent., it immediately showed very lively motions, lasting as long as one and a half hours. I have certainly seen a spermatozoon (in the micropyle of an egg which had probably been impregnated) in motion for that length of time. When further diluted the general motion seems to decrease; at 1.4 per cent. and below the spermatozoa remain motionless for a period of one to two hours, when there is again some motion, though less energetic and less general. When the spawn is diluted by an admixture of light sea water, there will always be a zone, within which the spermatozoa will be in motion. In this case, however, the liquid of the spawn has been suitably mixed with the water. This observation, however, should

* See Meyer: "*Untersuchungen über die physikalischen Verhältnisse der Ostsee,*" p. 10.

† *Jahresbericht* for 1871, p. 53.

‡ See Hensen: "*Physiologie der Zeugung*"; Leipzig, 1881, p. 95.

not be taken into account, because in natural impregnation the spawn immediately become mixed with the overplus of the surrounding medium.

I have also made experiments with solutions of rock-salt and of sea-salt which was not quite dry. The results were the same, and I found it impossible to dilute the solution of rock-salt as much as that of sea-water, without decreasing the mobility of the spermatozoa. The spawn of the plaice acts the same way as that of the cod.

This experience cannot, in my opinion, be generally applied, for otherwise the propagation of fish in the eastern part of the Baltic would come to a standstill, whilst we know that both cod and flounders are found beyond Memel. I am not able to furnish an explanation of the matter. In order to do this direct investigations would have to be made on the spot.

For the questions which both here and later will be of interest, the composition of the sea-water is of greater importance, as for instance, it cannot be immaterial what kind of salt is dissolved in the spawn mixture. I, therefore, give below the latest results as to the composition of the sea-water, from the analyses of the Norwegian expedition, principally based on Schmelck's * analysis, arranged in tabular manner for immediate practical use.

According to Jacobsen † the calcium in the Baltic amounts to 1.208 and 1.337 per cent. He also finds that the average quantity of sulphuric acid in the ocean is 6.493 per cent. of the salt a difference which would not be equalized, even if the salt was calculated at 99.6, instead of 100 parts. The remaining 0.36 parts are probably composed of iodine and bromine.

But to return to the eggs. It has already been shown that the eggs can develop both when floating near the surface and when lying at the bottom. The danger of their being devoured, therefore, seems to be varying according to circumstances. The floating eggs may be carried ashore, which, however, occurs comparatively seldom, or they may be devoured by other marine animals floating about near the surface. I do not consider these dangers as very great, but will, nevertheless, report on this subject below. In my opinion the danger is much greater when the eggs lie on the bottom. Here crabs, snails, worms, and star-fish are crawling about in large numbers; here shell-fish of different kinds, hidden in the bottom, whirl the currents of water which contain their food into their interior. Every fish floating past moves the water sufficiently to drive the eggs along the bottom and bring them within the reach of these whirlpools. In fact, the possibility of being devoured seems much greater. I am, so far at least, not able to form a definite opinion as to the quantity of marine animals at the bottom of the sea, which probably varies greatly in different locations. By digging in

* *Schmelck: "Der Norske Nordhaos expedition."* Christiania, 1882.

† *Jahresbericht*, 1871, p. 55, and 1874–'76, p. 241.

sandy parts of the coast I, as have others before me, found such a large quantity of small animals within a narrow space as to make it a matter of surprise that there are any eggs at all on the bottom of the sea.

Inorganic components of the sea-water.

[Per 100 parts salt.]

Metalloids and acids.		Metals.								Totals.
S.	C.	H.	Na.		K.	Mg.		Ca.		Metals.
2.523	0.0672	0.005654	30.361		1.12	3.766		1.1988		36.45145
			30.231	0.13006	1.12	2.58	1.186	1.176	0.0228	36.4458
O. in bases 1.3515	0.090476			0.220536						Oxides 3.87496
	0.7902						1.9762			
	0.4703							1.6463		
	0.00912								0.03192	
Cl. 55.249	46.609		76.84							Combinations of chlorine 89.18.
	1.02				2.14					
	7.62					10.2				
SO_3 6.307	3.9553						5.93			Combinations of sulphuric acid 9.93.
	2.3537							4		
CO_2 0.2739	0.24881	0.254464		0.475						Combinations of carbonic acid 0.532.
	0.02508								0.057	
Cl. + SO_3 + CO_2 61.8229			Na. Cl.	Na. HCO_3	K. Cl.	Mg. Cl_2	Mg. SO_4	Ca. SO_4	Ca. CO_3	Indissoluble combinations.
Salts										99.642

It is, at any rate, the normal condition of the eggs of these fish to float near the surface. I have, therefore, been led to suppose that in those years and those locations where the eggs remain floating, a quantitative calculation of their average would at least furnish an approximately correct estimate of the number of fish which had spawned at such times and in such locations.* In following up this idea we find that a vast and seemingly fertile field opens out for investigation, which, though barely entered, could not be passed in silence, all the more, because a knowledge of the facts given below would, a short time ago, have been of great value to me.

Counting the eggs of plaice not fully matured has given the following results:

Plaice 48 centimeters long, weight, 1,050 grams: ovary, 66 grams; number of eggs, 300,000.

* In order to prevent any erroneous ideas, I will define my idea of an "approximately correct estimate." At present I would not venture to decide, whether in the set near Eckernförde, taken as an example, there are annually caught 5 to 75 per cent. of all the grown fish, *i. e.*, whether four-fifths of the fish caught, or twenty times their number, live in that area; or to express it still differently, whether, scattered over the area, there would be 30 or 472 eggs to the square meter. The possibility of approaching a solution of this question by direct experiments is what I understand by an "approximately correct estimate."

Plaice 36 centimeters long, weight, 457 grams: ovary, 132.5 grams; number of eggs, 80,940.

Plaice 31 centimeters long, weight, 374 grams: ovary, 113.4 grams; number of eggs, 111,300.

Cod* 30 centimeters long weight, 525 grams: ovary, 141 grams; number of eggs, 305,900.

The smallest mature plaice which has come under my observation was 25.5 centimeters long, and weighed 142 grams without the ovary, which weighed 57 grams. It is, for the present, not very important to know exactly the average quantity of eggs of plaice. Not to make too high an estimate, I assume that a female plaice lays, on an average, 75,000, and codfish, per pound, 200,000 eggs. I furthermore assume that half of the fish caught are females, although passing through a fish market one gets the impression that there are more female than male plaice.†

Using these estimates in my calculations I obtained the following result: Near Eckernförde there were caught during a period of 9 years 1,706,848 plaice. Assuming that half of that number were females, we get 853,000 multiplied by 75,000=73,985,000,000 plaice eggs (228 cubic meters, or 231,348 kilograms). The quantity of cod caught was 354,162 pounds; assuming half of that quantity to have been females, we get 117,000 multiplied by 200,000=23,400,000,000 codfish eggs. The spawning season of both these kinds of fish lasts about two months, and it takes the young fish about fifteen days to be hatched. It is, therefore, probable that in the middle of the spawning season there is, on an average, at least one-fourth of that number of eggs in the fishing area at one and the same time. The calculation, therefore, shows that within the fishing area there must be at least 15,996,000,000 plaice eggs, and 5,850,000,000 codfish eggs.

The reliability of this calculation depends on the correctness of the statistics and a sufficient number of egg-counts. It is certain that we have not yet reached a sufficiently large number of the latter, but there is nothing to hinder more extensive counts. For the present, it is immaterial whether the figures obtained should be doubled or halved; for all we aim at is to get an approximate idea of the real condition of this matter. The objection might also be made, that of the total number of fish caught during the year, a portion is taken from the sea in a mature condition, and should, therefore, be subtracted. As regards my simple question, "Is the number of spawning fish as large, or larger, than the number of fish caught per annum?" the circumstance referred to is of no great weight, for the number of fish caught per annum is nothing but a number from which this question may conveniently be started, if you

* A *Platessa limanda* weighing 642¼ grams contained 807,467 eggs.

† The same applies to the codfish; but Earll found among 13,300 codfish 67 per cent. males. According to Möbius (paper read at the general meeting of the Schleswig-Holstein Fishery Association, March 1, 1883), a plaice weighing 450 grams contained 281,380 eggs. He counted 120,000 eggs per plaice, and two to three females to one male.

like, a measure which may serve as a starting point. Apart from this, the number of fish which, owing to their being caught during the spawning season, should be counted out, is fully compensated by the circumstance that we have only counted the number of fish caught by the Eckernförde fishermen, although within the same area many Kiel fishermen carry on fisheries.

This area embraces about 16 German square miles. One square mile = 5,500 hectares = 550,000 ares = 55,000,000 square meters; 16 square miles are, therefore, equal to 880,000,000 square meters. If the number of eggs which must be within the fishing area are distributed evenly, there will be per square meter 17 plaice and 6.6 codfish eggs, therefore in all 23.6 eggs; that is to say, a quantity of eggs sufficiently large to admit of an investigation.

There is no reason to suppose that in some other places in the Western Baltic there are fewer fish than the number given above; on the contrary, fishermen maintain that the places referred to are overstocked with fish, at least as regards plaice. If, therefore, the eggs laid within this area were driven to other places, a sufficient number of eggs, coming from the west or northeast, would take their place. It is probable, however, that a current, running for a long time continuously in one direction, would soon drive the eggs from the Western Baltic, unless there are other circumstances to prevent such an occurrence. This seems to be the case, and possibly makes this very basin of the sea a peculiarly interesting field for observation. It seems that the floating eggs cannot escape towards the north and towards the east. They cannot pass through the Great Belt, because (as Meyer has shown in his observations) the surface current going north through the Belt, in March, and especially in April, contains less than 1.8 per cent. salt. This current principally comes from the Eastern Baltic, and, therefore, does not carry any eggs. But if waters from the Western Baltic—containing eggs—mingle with it, they begin to sink, and therefore either get in a zone where there is hardly any current, or into the lower current floating south, which brings them back to the place from which they started. At any rate, the free movement of the eggs is hindered. Only direct observations, taken in the Great Belt, will show whether the movement of the eggs is stopped entirely, whether more eggs enter from the North Sea than those which leave the Baltic, or whether the reverse is the case. Towards the east the floating eggs cannot make much progress, because they would sink to the bottom, owing to the water gradually losing its saltness the farther east you get.

So far the practical results did not seem to correspond at all with the observations given above; nevertheless, I felt convinced that they were approximately correct. Hence in 1883 I commenced to make direct observations as to the quantity of the eggs, and below I give the results. I fished with three nets; the net for fishing at the bottom has already been described; it measured 38 centimeters in breadth; the floating surface net measured 80 centimeters in breadth; the vertical

net was closed and thus let down to the bottom, and hauled up thence. Its opening was 0.1182 square meters. The result of my observations was as follows:

Location.	Observations.	No. of eggs per square meter (surface).[15] Single haul.	No. of eggs per square meter (surface).[15] Percentage of all the hauls.
Off Danen-Rathen	*April* 7, 1883: 11 *hours from Kiel;* weather very fine, sea calm; specific gravity 1.0158 at 3.8° (at 17.5° = 1.0142 sp. g. = 1.86 per cent. salt): drew surface-net 96 meters; many diatoms, some *Sarsia;* the diatoms almost exclusively *Chätoceros*, *Sarsia tubulosa*, and occasionally *Dysmorphosa fulgurans*.—No eggs.		
Buoy No. 1 in the open sea, about 19 kilometers from Kiel.	Sp. g. 1.0157, at 2.7° (at 17.5° = 1.0142 sp. g.) surface-net 96 meters; diatoms; 420 eggs, among them 19 small ones; and among these 3 with drops of fat	5.5	
	Bottom-net on red algæ 96 meters; 23 eggs; among these 1 codfish egg, 19 plaice eggs, and 3 flounder eggs.	0.6	6.04
	Bottom-net; sandy bottom 50 meters; 44 eggs; among these 16 small ones; 28 plaice eggs and codfish eggs	1.2	
4 kilometers farther northeast.	Surface fished for 96 meters; many diatoms; 2,399 eggs; among these three with drops of fat (probably more), and 64 small eggs (flounder.)	31.2	32.2
	Bottom-net 99 meters, depth 10 fathoms; 33 large eggs, which did no longer float	1	
4 kilometers farther	Surface 96 meters; no diatoms; many entomostracans; 1,554 eggs; among these 19 with drops of fat; 65 flounders	20.1	20.1
Buoy No. 2; 15 kilometers from Kiel.	After sunset, the sea perfectly calm; fish playing near the surface. A great many diatoms; fished 180 meters; 6 eggs; 2 of these small; all eggs caught this day, young; no pigment in the eyes of any of the embyros. Back in Kiel at 10 p. m.		
Stoller-Grund; 21 kilometers from Kiel; 7 kilometers from Bilk.	*April* 13, 1883; 10½ *hours from Kiel.* East wind; sea a little rough. Sp. g. 1.0152 at 3.4°, at 17.5° 1.0138 sp. g. = 1.81 per cent. salt. Surface-net, 50 meters; diatoms; 53 eggs; 3 small eggs and 50 cod and plaice eggs	1.3	24
	Vertical net; depth 10 meters; hauled up net once; 2 eggs.	17	
	Bottom-net, 80 meters; stony bottom; 215 eggs; among these 34 small eggs, 65 plaice eggs, and 1 spoiled egg	7	
5 kilometers from the Stoller-Grund beacon; 12 kilometers from Bilk.	Surface-net 96 meters; diatoms; 179 eggs; among these 11 small ones	2.3	
	Surface-net, kept at same depth, drawn 96 meters; 35 eggs; among these 2 small ones; ½ egg per square meter		102
	Vertical net, hauled 3 times at a depth of 13 meters; 36 eggs	101	
	Bottom-net 96 meters; 13 eggs	0.4	
21 kilometers north of Bilk.	Surface-net 96 meters; many diatoms; 110 eggs	1.4	
25 kilometers north of Bilk.	Surface-net 96 meters; hardly any diatoms; 1,121 eggs; of these 124 small ones, and of these 60 with drops of fat	14.6	
	Bottom-net; many diatoms; no eggs, it seems; some of them, however, may have been overlooked	....	84.5
	Vertical net hauled 3 times, at a depth of 18 meters; 31 eggs	84.5	
28 kilometers north of Bilk; Aaro in view.	Sp. g. 1.0134, at 3.2° (at 17.5° = 1.0120 sp. g. = 1.54 per cent. salt). Surface net 96 meters; 3 eggs in the net, which probably had been in it from the last haul; no diatoms; many entomostracans. A strong current; it evidently was met by water which, driven by the east wind, was rapidly flowing from the Eastern Baltic towards the Sound and the Belts.		
5 kilometers north of Bilk	Sp. g. 1.0151 at 3.5° (at 17.5° 1.0135 sp. g. = 1.77 per cent. salt). Water rough; surface-net 50 meters, 58 eggs; no diatoms; many *Sarsia* and *entomostracans*	1.5	
Buoy No. 1	Same; 21 eggs; many eggs contained embryos which were considerably developed; back in Kiel at 9 p. m.	0.5	

[15] The calculation per square meter is as follows: The surface-net of a breadth of 0.8 meters drawn a distance of 96 meters, 0.8 = 76.8 square meters with (e. g.) 420 eggs, $\frac{420}{76.8} = 5.5$ eggs per square meter. The vertical net drawn 3 times corresponds to a surface of 3 × .01182 = 03546 square meters with a haul (e. g.) of 36 eggs, $\frac{36}{0.03546} = 101.5$ eggs per square meter. Add to this eggs at the bottom, 0.4 per square meter, and we get 102 eggs per square meter surface.

From that time the weather became unfavorable. Trips made on the 27th of April, and during the night from the 11th to the 12th of May, proved failures, because the wind, and partly also the specific gravity of the water, made it impossible to take any observations.

The observations given above share all the shortcomings of first attempts. On the first trip I had not taken a vertical net; and even on the second trip I had no distinct idea of the importance of this apparatus, which I had used of too small a size. I also made the mistake of neglecting to examine everywhere the deep water and the bottom. Moreover, I could not count the eggs immediately, and it was impossible to make them the subject of systematic observations. As regards rational observations of the density of the eggs, I was not fully prepared either as to apparatus or as to the preliminary studies which should have preceded such observations.

Nevertheless, I am of opinion that, in some respects at least, the results are important. In the first place, of course, as to the methods for pursuing such investigations; but in the second place I feel compelled by the first impressions received from these quantitative preliminary experiments, to propound the idea, that it is principally quantitative experiments—not only as to eggs, but also as to the floating diatoms, entomostracans, &c. (all of which use their power of motion principally in a vertical direction)—which will bring about such a development of the biology of the sea, and the trades connected therewith, as we have a right to demand of science. The great problem, What cycles of organic masses are fanned into life by the biological use of the sun-power, to which the large sea surfaces of the globe are exposed, has practically been barely approached. We know from Murray's observations a little as regards the life cycles of the ocean; but we do not know through what long stages the parasitism of animal beings runs on the light-born world of plants. We do not know whether the principal cycle should be called diatom-monads, or whether some important cycle still embraces the vertebrates. In all probability both is the case; but quantitative investigations alone can reveal to us which must be considered the principal and which the subordinate type.

As regards the method to be pursued in this special case, I would state that, without a steamship suitably arranged for the purpose, not much can be done; I will not, however, insist on this.

For fishing I would recommend a vertical net of somewhat large dimensions; the best will be one with a ring having a diameter of 80 centimeters, so that it is possible to fish a space of 0.5 square meters. The net itself should almost taper off in a sharp point. It is very important that one should be able to fish with this kind of net even in a somewhat rough sea.

The surface-net is not as essential; under favorable circumstances it yields larger masses than can be easily manipulated. Occasionally, however, it will be desirable to catch large quantities with a view to

make comparisons of the different stages of development and of the different species of fish. Nets of the breadth of one meter should be used, so that, after the eggs have been counted, there is no risk of being hindered by calculations from making the best possible use of fine weather.

The bottom-net referred to in my observations can, probably, be better arranged for quantitative investigations. The results which I obtained with this net hardly give the number of eggs high enough. Such a net, moreover, can only be used when the sea is very calm, as the waves disturb the even movement very much. This might be remedied by tying a weight to it.

I have based my calculation on the supposition that the water passes through the opening of the hoop of the net, just as if there was no net. This is, of course, not absolutely correct, because the meshes of the net offer resistance to the water. It is my opinion that all water, with the exception of a very small quantity in front of the net, goes through it, when the motion is slow; for my observations showed that objects floating in front of the net did not avoid it. So far I have not been able to discover any way to utilize the water which avoids the net. It is, however, sufficient to know that, in consequence of this circumstance, one has obtained a catch which is too small in proportion to the fishing area. The length of the area is obtained by means of a log with a line divided into meters (a white rag being fastened to the line at every two meters, and a different-colored rag at every 10 meters).

Besides the apparatus mentioned, another net is required, with which fishing can be carried on at full, or at any rate, half-steam power. The apparatus required is one which will decrease one-tenth the velocity of the current passing through the mull-net at the rate of 10 kilometers per hour. For this purpose I have had constructed a hollow cane with an obtuse top, made of wicker-work, the base of the cone also being closed by wicker-work. The dimensions of this apparatus were as follows: Diameter of opening at top, 8 centimeters; diameter of base, 32 centimeters; depth, 25 centimeters. In the hoop is placed a mull-net of similar shape. The whole is supported by a pole and rope attached to the prow of the vessel. I intend to still further improve this apparatus; but even in its present condition, it retains alive and well a portion of the medusæ and crabs which have been caught, even if the current should have a velocity of 9.7 kilometers per hour. So far, this apparatus cannot yet be used for catching large quantities, but it can direct attention—through different particles adhering to it—to every change in the character of the contents of the water.

A second condition of a successful method is the possibility of ascertaining immediately and quickly the quantity and quality of the catch; for only by the possession of this knowledge can systematic observations be carried on.

As the nets have to be washed, a good deal of water—at least 3 to 4

liters—has to be examined; and small crabs, diatoms, and medusæ often prove great hindrances. The eggs will cling so firm to the jelly-like mass of the medusæ, as soon as the water has been removed, that it becomes exceedingly hard to find them and separate them from the object to which they adhere. The *Sarsia*, which became a special source of annoyance, do not make their appearance in the Baltic in any considerable numbers till the end of the egg-period; and they have finally to be removed by means of a sieve in the wide openings. The diatoms which often are found in quantities a hundred and thousand times as great as that of the eggs, prove a serious hindrance. They and the entomostracans—which are not near as annoying—can quickly be removed by means of the following apparatus: To a metal tube having a diameter of 8 centimeters little feet are attached, measuring from 3 to 4 millimeters in length, so that it can be placed vertically on a glass plate. In this metal tube another tube fits, which is partly arranged as a screw, so that according to the necessity of the case, it may rise from 1 to 4 millimeters above the glass plate on which it rests. Into this tubular vessel the water containing the eggs is poured. The water immediately flows off through the slit below, whilst the eggs and all other larger objects remain on the glass plate. For the first idea of this exceedingly practical apparatus—which I have only described above as to its leading principles (in the improved edition it has only one foot)—I am obliged to Count Spee, assistant at the physiological institute, to whom I hereby also express my best thanks for his cheerful assistance during my excursions. The counting may be done conveniently after the tube has been removed from the glass, by placing over the eggs a thin sheet of mica, on which squares are marked. Unfortunately I did not have the opportunity of gathering observations in this respect.

It need hardly be mentioned that the discovery of floating eggs announces to the scientific investigator the presence of the kind of fish with which these eggs originate, and that, by following them against the current, the spawning places must ultimately be reached, and that the distribution of the eggs will indicate the direction of the currents.

I shall now endeavor to explain the view that it is possible to obtain an approximately correct estimate as to the quantity of the eggs. In the first place a distinction must be made between the eggs which float and those which do not float; for, as regards the latter, it seems utterly impossible to get at even an approximately correct estimate, and as regards the floating eggs, it should be borne in mind that, if sufficient time is allowed, they will gradually spread evenly throughout the sea which is before them. I must confess that I have considered this fact as self-evident, and have, therefore, neglected to gather experimental data in this direction. I can therefore merely state that, (1) eggs which were thrown into the sea for the purpose of impregnation did not remain close together, but were scattered in a few minutes; (2) the result of my observations given above (observations made at an interval of six days)

strongly favor the idea that the eggs scatter evenly over a considerable area. I have not found any data relative to the mechanical distribution of such objects by shaking; nevertheless it remains an undoubted empiric fact that the process of shaking and stirring causes an even distribution of hard bodies, such as grains of corn or seed, and of hard bodies in fluids (*e. g.*, in emulsions).

The reason why irregular pushing motions, made in every direction and of a certain duration, applied to a large number of bodies, produce a tolerably even distribution of such bodies, must be found in the following circumstances:

Bodies like eggs receive such pushes either in a direction perpendicular to their radius or in any other direction. In the latter case the pushing motion becomes divided, one motion turning the eggs, the other simply pushing them; but as in the water the entire surface of the egg is almost invariably struck simultaneously in one and the same direction, rotation sets in but very seldom.

If thrusts of equal strength struck the globe at all its radii at one and the same time, for whose endless number of radii we will assume a certain large fixed number, the globe would not move; and if all these thrusts were made in quick succession, the globe would, after a certain number of thrusts, assume its original position. The intervals in which these thrusts are made may vary; it is also possible that each radius must receive a three or four fold number of thrusts before the cycle of motions is completed; but the globe of the egg would invariably have to return to the same spot. If the motions, however, become entirely irregular it becomes highly improbable that a cycle of motions will be completed after a small number of such thrusts; only after an illimitable number of thrusts, therefore after an illimitable period has elapsed, there will be a probability that such a series of cycles has been completed, and that, thereby, the body has been brought back to its old place or within its neighborhood.

What applies to one egg, applies to all. There remains, therefore, only the possibility that all eggs move from their starting-point in one and the same direction, and that, consequently, they do not scatter. This becomes all the more improbable the larger the number of the eggs; for this would presuppose that all the thrusts which strike the eggs are made absolutely parallel with each other. This may occasionally be the case in currents; but as soon as the thrusts are made irregularly in different directions, the eggs will scatter. Every radius of each individual egg runs the same chance of being struck, and as the thrusts are made in different directions, the individual eggs will receive them in different ways. The more the eggs are scattered, all the more—and in proportion to the cube of the distances—will the probability disappear that they will meet again at any time.

It will not be necessary to discuss the question in what manner an even distribution through space is finally brought about, because such

a distribution would require too long a time to occur in the case in question. If there is actually a very considerable uniformity in the distribution of the eggs, it is mainly caused by the circumstance that probably the spawning process along the coasts takes place within an area embracing the Western Baltic, so that thence the mingling can take place with greater ease.

In our special case, the question is, whether actual thrusts or pushes are made against the eggs in all directions? Simple waves have only motions resembling that of the pendulum, ending perpendicularly towards the surface; they cannot, therefore, scatter the eggs horizontally. The waves, however, are not simple waves, but each large wave consists of a number of small waves of different size. By superposition they cause the tops and valleys of the waves to become sharp edges. The tops are bent by the wind, and are even torn and dashed into a mass of spray, and the sharp edges of the valleys fall down. Thus there arise numerous horizontal movements, and when the waves begin to foam, when during a storm the sea resembles a seething caldron, the horizontal thrusts are sufficiently numerous. Possibly the eggs also glide along the surface of the waves, and the wind lashing the surface of the water scatters the eggs, both those which float near the tops and those which are in the valleys. It can hardly be presumed, however, that such occurrences can do more than cause the distribution of the eggs, which were originally close together, over a limited area, in the most favorable case, about one square mile. Direct observations frequently offer technical difficulties, for when the sea is rough, bodies sunk below the surface are immediately lost to sight. I let three glass floats, which, like the areometers, rose but little above the surface, swim in the Kiel harbor when the waves were but small, but when there was a tolerably strong west wind. After they had been separated and had again come together, the smallest of the three was, after 10 minutes, found about 3 meters from the two others, which were deeper in the water, and which were about one-half meter from each other. Soon after this observation I unfortunately lost sight of them. Three meters in 10 minutes makes 18 meters per hour, and 6 kilometers in 14 days; and as the waves were very small when I made this experiment, and as floats like those employed by me have rather an unfavorable shape, the area of one square mile (German) for the open sea, as given above, does not appear too large.

It is certain that the currents which are caused by the changes of the pressure of the air on the water, and which run parallel with the wind, have likewise a considerable influence on the distribution of the eggs. These currents cause a very considerable motion in the Baltic; in the open sea they certainly run frequently ⅛ mile (German) an hour, therefore in 8 hours 7.5 kilometers. This causes a considerable motion and upper and lower currents, which may cross each other at different points, and taking into account the constantly progressing distribution caused by the motion of the waves, it becomes probable that all these motions

combined cause the distribution of the eggs over a large area. The occurrence in coast waters of water-areas, belonging according to their character and fauna to the high seas, as has been observed for a long time in the Gulf of Naples, will influence the distribution of the eggs. The mechanism of the currents caused thereby has so far, however, not yet been made the subject of scientific investigation.

On the other hand, however, currents may also impede the even distribution of the eggs, partly by causing stoppages and whirlpools in the water, but principally by changing the specific gravity of the water. In my opinion the very rare occurrence of codfish and plaice eggs in the harbor and the Bay of Kiel must be explained, at least in part, by the circumstance that the fresh water which flows into the harbor from the river Schwentine and other streams hinders the entrance of the eggs. By such currents and the water losing some of its saltness the distribution of the eggs at the bottom may became very irregular. My observations, however, did not clear up this question. It is also probable that during storms the bottom of the shallow Baltic is sufficiently stirred up to scatter the eggs lying at the bottom.

My observations, however, have proved, at least made, it highly probable that eggs are scattered in the Baltic over a large area. Even far out in the Baltic I found numerous eggs, viz, 85 per square meter of the surface, and only the entrance of fresh water from the north prevented further observations. The evenness of the distribution has also become more probable by my having found 32 and 20.2 eggs per square meter at intervals of one half mile (German) in a perfectly calm sea. I must also state that I always found in these masses of eggs not only different kinds of eggs, but also eggs in many different stages of development. It is hardly probable that the fish from which these eggs came had spawned all over the Baltic, the different species mingling with each other.

However this may be, the quantitative examination of this subject (perhaps by fishing along the sides of a triangular area) is of great interest in itself, for only thereby we can arrive at an approximately correct knowledge of the whereabouts and the fate of the eggs, and of the dangers which threaten them at this stage of their development. It will, moreover, be a great advantage, if our investigations as to the occurrence of different kinds of fish can be made without regard to the statements of fishermen and data gathered during the fisheries. The latter are occasionally very one-sided.

As regards the idea from which I started—to obtain an approximate estimate as to the quantity of certain kinds of fish found within certain areas of water—the reader will, after all that has been said, be better able to appreciate the difficulties connected with these observations.

It might be possible to obtain, by numerous counts, an approximate estimate of the number of eggs per kilogram of spawning fish; but then the question arises, How many of these eggs are actually impreg-

nated? The eggs which have not been impregnated may remain floating for several days. It would, therefore, be necessary, for obtaining tolerably correct average figures, to gather the eggs above the spawning fish, and determine the percentage of eggs which have not been impregnated, by taking them from the water in the most careful manner. The question can only be decided if the eggs can be kept alive for about 24 hours, which is only possible by taking ice along in the boat. In boats which are not constructed in such a manner as to allow of microscopic observations on board, this is recommended under all circumstances, for below deck the water soon becomes warm, and on deck it is difficult to protect the glass vessels against the sun, as the vessel often changes her course, and as the attention of the scientist is required in other directions.

We furthermore ask, How many of the eggs die prematurely? With regard to this question I feel justified to state that their number is, on the whole, not very large. Dead eggs, as I have found by direct observations in the aquarium, will very well keep from 8 to 14 days. If, therefore, there had been any, I must have caught some with the bottom-net. It is true that I brought up a certain number of such eggs—every catch yielding one or two, and on the 27th of April I even got—near Buoy No. 1—16 dead eggs along with 50 live ones, the average distribution being 1.8 egg per square meter of the bottom; but here the spawning period was over, and a large number of eggs had probably accumulated owing to this fact. Finally, the exceedingly difficult question remains to be answered—how many eggs are devoured by various marine animals. The dangers which arise, when the eggs touch the bottom, have already been mentioned.

The Entomostracans do not seem to hurt the eggs. I am, of course, not absolutely certain on this point, as eggs which had been bitten would run out; and as it requires special observations to ascertain whether egg-shells are found which are sinking or about to sink. The number of small crustaceans is frequently so great that the eggs must be entirely annihilated if these animals were among their enemies. I have also often, in the large aquarium of the commission, observed eggs floating among the crustaceans, and never could I find that they were in the least molested by them.

Fish are hardly dangerous to the scattered eggs, for on account of their great transperency they are, when occurring singly, hardly perceptible, nor would it pay the fish to hunt for them. Sars says: "It seems that not only other marine animals, but even the codfish themselves, when they return to the high sea, destroy a large number of the eggs which fill the ocean." Although the fact does not seem to be positively proved by this statement, it seems certain that, wherever the eggs occur in very dense masses, they are devoured by fish. No estimate as to the quantity of eggs destroyed in this manner could be gained, unless one could be directly over the spawning masses of fish.

The *medusæ* are probably a dangerous enemy to the eggs. Earle states:

"One day I placed a medusa or medusoid, measuring only 1½ inch in diameter, in a trough containing eggs; and in less than five minutes it had gotten 70 eggs in its tentacles, which weighed them down to such a degree as to cause them to be torn off the medusa, as it floated through the water."

The wording of this statement does not prove that the *medusæ* actually eat and digest fish eggs, but I have not the slightest doubt that they do this, as, according to Sars's observations, which are confirmed by mine, they even take young fish. It is only the *medusæ* proper, however, and among these only the *Medusa aurita* and *Cyanea capillata*, which can come into consideration, as far as the Baltic is concerned. In 1882, the *Cyanea* was very numerous in the Bay of Kiel, but in March they were still so small that they could not prove dangerous to the eggs. The *Medusa aurita*, so far as I know, makes its appearance later in the season. In 1883, both these kinds were so scarce, that I only met with 3 or 4, and during that year at least they cannot possibly have destroyed many eggs.

On the 14th of May I made the somewhat unexpected observation that the small *Sarsia tubulosa*, measuring only 1½ centimeter, eats fish eggs. I had placed a small number of eggs with broken yolks, measuring on an average 1.2 millimeters, in a glass vessel into which a large *sarsia* had accidentally found its way. When later I took out the eggs for the purpose of examining them several were missing, and the stomach part of the *sarsiæ* was swelled out considerably. In dissecting the *sarsia*, I found an egg in the process of decomposition, the shell being still well preserved. It, therefore, seems highly probable that, also in the open sea, the *sarsiæ* will seize and swallow eggs. I have, of course, not been able to make direct observations on this subject. For the present I do not, therefore, know whether the *sarsiæ* will swallow the larger eggs of the codfish and plaice, and how large they must be to do this. In March and April the *sarsiæ* are generally very small and immature, and their sexual organs do not reach perfection till May. If it should be proved that young *sarsiæ* can swallow eggs, it may be presumed that they destroy a very large number of eggs especially in the bays, for here a single haul of the net often brings up handfuls of these animals. In the open sea I have not found them so frequently, but here I found the *Syncocyne sarsii*, so that there can be no doubt as to their occurrence.

These different facts, and in addition the possibility that the wind drives ashore large quantities of eggs from the surface water, show that the counting of eggs can only give minimum figures as to the number of fish; but even these would be valuable.

Provided the water possesses sufficient gravity, no portion of the sea is better suited for such experiments than the western basin of the Baltic.

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NOTE.—The references are to page-figures in brackets,

XVII.—A CONTRIBUTION TO THE EMBRYOGRAPHY OF OSSEOUS FISHES, WITH SPECIAL REFERENCE TO THE DEVELOPMENT OF THE COD (GADUS MORRHUA).

By John A. Ryder.

1.—Introductory.

The following paper, as far as it relates to the codfish, is mainly the result of studies carried on at Wood's Holl, Mass., during the month of January, 1881, and at Fulton Market, New York, in February, 1882. At Wood's Holl, the writer, as investigator, was associated with Col. M. McDonald and Capt. H. C. Chester, the latter having been previously engaged, together with Mr. R. E. Earll and Mr. F. N. Clark, in an attempt to propagate the cod artificially at Gloucester, Mass., in 1880. It is now claimed by the fishermen in the vicinity of Gloucester and Wood's Holl that the results of the work of the U. S. Fish Commission, in placing artificially reared embryos of this species into the waters of these localities, have already shown themselves as shoals of young fish, the presence of which it is not possible to account for on any other theory than that they are the survivors of those partially reared by the two parties which have been alluded to above as being sent out by the U. S. Fish Commissioner. The fullest measure of success, notwithstanding the gratifying result claimed for us by the fishermen, it has not yet been our lot to attain. The mortality of the artificially fertilized ova is still very great under apparently the best conditions, though this fact need not hinder us in further endeavors to multiply this exceedingly valuable food-fish of our northern coasts. If the annual destruction of ova which accompanies the marketing of the adult fish in New York City alone could in any way be abated, the future of the race of codfish would in a great measure be assured. Inasmuch as a very large proportion of the fish brought to New York are alive and preserved for days in large floating cars in the harbor, the artificial fertilization of many hundreds of millions of ova annually would be a matter of no great difficulty. Such a plan has in fact been already proposed by Professor Baird. The ova after fertilization are to be transported in launches some distance from the filthy and too slightly saline water of New York Harbor, and poured into the waters of the open sound or bay, to undergo further development under natural conditions without further care from the hand of man. This plan seems feasible, and one which will demand but comparatively small outlay in its execution.

The waters of New York Harbor were found to have less than half the normal average specific gravity of those of the open sea, a difficulty which was overcome in some measure by the use of artificial sea water of a specific gravity of 1.024°. Ova fertilized in the artificial sea water not only developed as well as could be expected under the other conditions in which they were placed, but were also shipped from New York to Washington sealed up in one-quart glass jars, packed in cracked ice, and also upon trays covered with dampened cloths. The former method of transportation, however, seemed to give the best results.

Almost all of the observations on the embryo codfish here recorded were made at Wood's Holl in January, 1881, and relate mainly to what could be observed of the development of the living eggs, without further preparation, under the microscope, the small dimensions of the ova and hatched embryos being at the time a great bar to the more thorough investigation which I have since made with other forms with somewhat larger ova. What has been learned by means of sections in other types has been used only in so far as was evidently applicable on general principles. Taken as a whole, these studies must be regarded as dealing with the eggs and embryos of *Gadus morrhua* as living transparent objects, and not as a final monography, such as would be possible had series of sections and other preparations been employed in addition. The outlines of the figures I believe to be approximately correct, all of them having been drawn with care with the aid of the camera lucida. The work of Sars on the same species was unfortunately not illustrated, and is therefore not as valuable as it might have been. If it had been accompanied by figures, I should probably hesitate to publish several of the accompanying sketches, because the deft pencil of the Norwegian naturalist would have portrayed with much greater skill most of the stages here discussed. Mr. Earll's valuable contribution* to our knowledge of this fish, its habits, and its development, cannot be passed over in silence, as a good many new facts are brought to light not elsewhere recorded. Unfortunately, the observations here placed upon record relate only to a period of about thirty days in all. The later changes beyond the oldest stage here discussed would without doubt be of as much interest and importance to fish culturists as the earlier ones.

The observations recorded throughout the text relating to other forms, not here figured, will, I believe, prove of interest to those engaged in similar studies. These embryological observations have been made at various times and places during the last three years, and embrace as subjects a considerable number of genera belonging to widely separated families. Some of them have been already published, but I have not felt prepared to put the facts accumulated into a connected form, as a

* A report on the history and present condition of the shore cod-fisheries of Cape Ann, Massachusetts, together with notes on the natural history and artificial propagation of the species. By R. E. Earll. Report of the U. S. Commissioner of Fisheries for 1878, pp. 684–740.

general survey of the ground which I have traversed, until quite recently. The observations in addition to those on the development of the cod were made principally at Cherrystone and New Point Comfort, Va., Havre de Grace, Md., and Washington, D. C.

2.—THE OVA AND OVARIES OF THE COD AND OTHER FISHES.

The mature eggs of the cod measure 1.3 millimeters in diameter, or one-nineteenth of an inch, and are covered by a vitelline membrane which is not porous or enveloped in adhesive material. It is thin, very transparent, and laminated, as has been stated by Sars, and at one point is perforated by a single minute opening, the micropyle; the membrane is somewhat thicker in the immediate vicinity of this opening. In figures 1, 6, and 7, the micropyle is shown at the lower pole of the egg, and in figure 5, very much magnified, a portion of the surrounding membrane, together with the form of the tube of the micropyle, is seen in optic section. The outer opening is situated in a funnel-shaped depression, the rim of which is defined from the surface of the membrane by a furrow running round it. From the funnel-shaped outer opening a fine canal passes inwards to end in the center of another wider funnel-shaped depression on the inner surface of the membrane at *mi'*, but which is situated upon a considerable internal elevation. As far as the writer has been able to make out with very excellent lenses, this is the only opening into the cod's egg through which communication is established between the water surrounding it and the space inside between the vitellus and the vitelline membrane.

In other species the character of the egg membrane is quite different, since it is often found that the whole surface of the egg membrane is very regularly perforated by very fine canals, so that when it is viewed in optic section under the microscope numerous fine radiating striæ are found traversing the membrane in a direction vertical to its external surface. These striæ are due to the presence of fine canals, which may open at the apices of minute papillæ, as we find in the case of the membrane of the shad's egg; in other cases we may find the surface marked as if by fine lines crossing each other at definite angles. An egg membrane which is minutely perforated, as above described, is known as a *zona radiata*, a name proposed by Waldeyer.

The cod's egg is without the zona radiata found inclosing the egg proper of the shad, whitefish, and sculpin, and, inasmuch as it is unquestionably true that a micropyle perforates the zona in a number of these cases, it does not appear that sufficient grounds exist for the declaration that a micropyle perforates the zona radiata alone, in the face of the fact that the vitelline membrane only is perforated in this one instance.

Waldeyer holds that the vitelline membrane is a secretion from the cells of the follicle in which the ovum is developed. Lereboullet regarded it as a chorion, a conception of it which has now been gen-

erally abandoned. Œllacher argues for its composite nature, as does Kupffer in the case of the herring's egg. Balbiani thinks it best to adopt the name of egg-capsule for the covering of the egg, as by that means he does not commit himself as to its origin.

The micropyle of the fish ovum was first observed in the egg of *Syngnathus ophidion*, one of the pipe fishes, by Doyère, in 1849; the next observations were those of Ransom and Bruch, 1855, and it was afterwards more fully discussed by the former.

The pore canals in the zona radiata were discovered by Johannes Müller in 1854.

Sars has counted the laminæ in the vitelline membrane of the cod's egg, but the writer has not been able to assure himself so fully upon this point. Under ordinary conditions, when a portion of the membrane is examined which has been sharply folded upon itself, no such laminar structure is visible until subjected for some time to the action of a 1 per cent. solution of osmic acid, when the laminated structure spoken of is produced, but whether simply by the action of the acid or as a normal feature of the structure of the membrane may be a question.

The immature ovarian eggs of the cod may be studied by taking an ovarian lobule from the ovary of an adult female and placing it in a compressorium under the microscope. Under a power of 150 diameters we learn that, while there are many eggs one-half or fully grown, there are many more which are very immature, and are only revealed to our vision by the aid of considerable magnification. Nor is this all; we find that there may be three well-marked stages of egg development distinguished. These are best seen when the fragment of ovarian tissue has been subjected to sufficient compression to render the ova more apparent by transmitted light, and if the observer will take care to use a 1 per cent. solution of acetic acid, the nuclei of the unripe eggs will be brought into bold relief by the action of this reagent in a few minutes. He will notice, first of all, that the immature ova measure all the way from a little over 1^{mm} down to a very few hundredths. The smallest ova are involved in the fine cellular material of the ovary from which the eggs themselves are slowly differentiated as the growth of the ovary proceeds, when well supplied with blood and nutritive matter, previous to and during the spawning term. When once large enough to be readily distinguished from the indifferent cells which inclose them, the growing egg, or ovicells, are distinguished from the mature ones by inclosing inside them a comparatively large and very granular rounded body, the nucleus or germinative vesicle, which frequently measures half as much in diameter as the whole egg. The protoplasm which surrounds the germinative vesicle is granular, quite transparent, and of a yellowish or pale amber tint, while the vesicle itself is darker in color and more opaque on account of its granular walls. The position of the germinative vesicle is always central in these immature eggs, and it is not until the ova are approaching maturity that any marked change in its form

or position occurs. When the eggs are one-half or nearly full grown, the protoplasm surrounding the germinative vesicle becomes uniformly corpuscular, and, hence, different in character from that found in quite young eggs. Such partly developed ova, when examined with reflected light, appear whitish instead of a clear, transparent, yellowish tint, such as would be noticed in ripe eggs. This difference in color is due to a change in the character of the plasma enveloping the germinative vesicle, for immediately that the eggs are mature and ready to leave the intraovarian cavity they acquire a remarkable transparency. This must be due to a comparatively sudden blending of the protoplasmic corpuscles of the egg into a homogeneous material, very like the white or colorless albumen of a hen's egg, but differs from the latter again in that it becomes whitish,—coagulates when brought into direct contact with water. It would be a matter of great interest to know the chemical composition of the yelks of the ova of a large number of genera. Equally important it is to know what particular proteids enter into their composition besides the oils and coloring matters characteristic of certain species. The yelk material of the cod's egg in its change from the younger granular state is, however, not perfectly homogeneous, any more than that of the shad. Here, as in that species, it is made up of very minute corpuscles, which are themselves very transparent and involved in a clear plasma. I have never isolated the flat, somewhat crystalloidal bodies which have been observed in the eggs of Cyprinoids. This proteid has been named *ichthyine* by Valenciennes and Fremy. Such ovoidal bodies constitute almost the entire bulk of the ova of the American Cycloganoid, *Amia calva*, as I have had the opportunity to learn from an examination of a fresh, nearly mature ovary of this fish in New York in February, 1882. It is not a little remarkable that, amidst all the diversity of color and size of the ova of Teleostean fishes, we should also find differences in the microscopic character of the yelk of the different species; a fact which ought, once for all, to be sufficient to silence a mischievous class of compilers who insist upon asserting that the germs of different species of animals are so nearly alike as to be indistinguishable from one another. The office of the yelk is to supply nutrient matter to the embryo which is superimposed upon it, and the membranes of which completely inclose it. We may in ripe ova distinguish, first, yelk corpuscles, these again sometimes aggregated into large granular bodies, which may themselves be involved in a meshwork continuous with the cortical layer from which the germ disk is derived. Finally, oil drops may be present in many other forms, such as *Hippocampus*, *Siphostoma*, *Cybium*, *Parephippus*, and all Salmonoids which I have ever observed, to which we may add Cyprinodonts and some Percoids. Exceptions in regard to structure occur, however, even within the limits of families; for example, the cod's egg is without any oil drop, while in another Gadoid, *Brosmius americanus*, the eggs contain a large pinkish oil drop, placed eccentrically, like that of the Spanish

mackerel, which, as in the latter, no doubt causes the ovum to float during development.

With the further growth and maturation of the ovicells in the lobules of the functionally active ovary it becomes possible, after they have attained the dimensions of about .3^{mm}, to discern that each one is inclosed in a more or less well-defined covering of small cells; the ovisac, ovarian capsule or follicle, in its early stages at least, is often, if not usually, composed of flattened or of columnar cells. The history of the development of the ovary in bony fishes is not well known, and little has been written upon the subject of a satisfactory character, except more recently by McLeod, Waldeyer, and Brock, from whose researches it would appear that the ovary makes its appearance as a differentiation of two bands of peritoneal epithelium placed on the dorsal side of the body cavity, on either side of the mesentery. So far as known, the early development of the generative tissues is similar in sharks and true fishes. The bands of primitive germinal cells are known as the germinal epithelium. The reproductive cells are distinguished from the adjacent indifferent epithelium at a very early stage, and are known as *primitive ova*. These primitive ova or germinal cells become either ova or spermatozoa, it being impossible to distinguish what will be their fate when they first make their appearance. In some forms the primitive ova are soon aggregated into masses, which break up into ampullæ, which are afterwards attached to tubes derived from the smaller investing and indifferent cells. In most Teleosts the ovary in a developed state is lobulated, each lobule consisting of great numbers of ova in different stages of development. These lobules may be arranged in a longitudinal or transverse manner; the latter appears to be the most usual mode. It is doubtless true that in some fishes the ovarian lobules, when transversely arranged, correspond more or less closely to the muscular and vertebral segments. In other cases no such arrangement is apparent; the germinal fold may be rolled upon itself longitudinally, or the ovarian rudiment may appear to be derived from the anterior portion of the dorsal peritoneal wall of the abdominal cavity, as in *Gambusia patruelis*, since in embryos of this species which have not yet absorbed their yelk-sacks we may see the primitive generative structures as a pair of cylindrical organs lying in the upper part of the abdominal cavity, attached to the peritoneum only at their anterior ends. Later, when the ovary is developed, no trace of lobulation is apparent, and the small number of ova which are matured remind one of a bunch of grapes attached to the stem, the latter representing ideally the vessels which nourish the growing ova. In other forms the arrangement is very different. In the cod the ovary is enormously developed, and is an internally lobulated and closed, paired organ, opening outward by way of a wide duct behind the vent; the body of the ovary itself extends some distance behind the vent into a prolongation of the abdominal cavity, where its two halves are conjoined. In very immature stages of development of

the ovary, in Teleosts in which this organ is lobulated, I have never seen any evidence of the tubulation met with in some vertebrates. With the male organs it is different; here seminal tubules are developed in a very distinct manner. The lobules in an immature state in reality appear to represent folds of the germinal epithelium, on the exterior surface of which the ova develop in their sacks, which rupture when the ova are mature, allowing the latter to fall into the intraovarian space, where the ovary is a closed saccular organ, or into the abdominal cavity, as in Salmonoids and lampreys. The ovarian leaflets or lobules in an immature state show a very distinct median vascular stem, from which the blood supply for the individual follicles is derived, as may be seen in the immature or undeveloped ovary of *Alosa sapidissima.* The follicles themselves serve at once to contain the growing egg, and by means of a net-work of fine capillary vessels, which traverses its substance, to supply it with proteids, an accumulation of which the egg really represents. The follicle may be greatly modified, as in *Gambusia patruelis*, a viviparous form. Here it is apparently structureless, as far as I have been able to make out; but in reality it is probably covered by a layer of much flattened cells, which, together with an extremely thin vitelline membrane underneath, form the walls of the follicular capillary net-work, the blood cells within which, with their nuclei, are clearly shown in hardened and stained preparations. But these are the only histological elements which can certainly be made out. The capillary net-work is distributed from a thickened annulus at one pole of the follicle, where the afferent nutrient vessel enters and the vein passes off. Through the annulus above alluded to there is an opening, the *follicular pore*, which is variable in size, and answers to the micropyle of the eggs of other fishes. Through this pore the milt of the male apparently finds access during the act of copulation. Impregnation is thus accomplished within the ovary of the female, and development of the embryo proceeds as in oviparous species. The follicle, however, now acquires a new function, in that it not only serves to develop the egg until a mobile embryo is produced, but also functionates partly as the embryonic envelope, and partly as a respiratory structure, by means of which the exchange of gases necessary to the life of the embryo is accomplished. Whether any actual conveyance of nutriment from the maternal organism during this intrafollicular development of the embryo takes place is extremely doubtful, in that we find the yelk-sack with its vessels developed just as in many species which develope oviparously. Respiration is undoubtedly effected, however, by this quasi-placental apparatus of *Gambusia*, for we find the vascular apparatus of the embryos very highly developed long before their escape from the follicle; in fact, the branchial leaflets are already so far developed as to be pinnate in structure, with vascular loops formed in the pinnæ, a condition of affairs not usually attained by the embryos of oviparous forms until

after a considerable time, several days or even two weeks after hatching, according to the species.

The mucus usually found in the functionally active ovary, completely covering the ova which have fallen into the ovarian cavity, is of considerable interest. Its origin is somewhat obscure, but it is in the highest degree probable that it is derived from the follicles at the time of their rupture and the escape of the eggs. It is evidently a lubricant to facilitate the escape of the ova from the ovarian cavity or abdomen into the open water. In other cases, where the ova are enveloped in an adhesive mucous material, as in the cases of *Perca*, *Cottus*, *Idus*, *Esox*, *Clupea*, *Pomolobus*, *Apeltes*, etc., its function is altogether different, and serves, in addition, either to glue the eggs together in masses or bands, or to cause them to adhere firmly to fixed objects in the water. Sometimes the eggs adhere in ribbon-like masses, such as is said to be the case with the eggs of the perch (*Perca flavescens*). Mr. G. P. Dunbar reports in the American Naturalist that the eggs of *Atractosteus* are held suspended in a thick, jelly-like substance, forming long ropes several inches in diameter, which are hung on old snags, roots, or branches of trees that have fallen into the water. The spawn has much the appearance of that of the frog, with the exception of the form it assumes and the size of the eggs. Other contrivances for the suspension of fish ova have been described by Haeckel and Kölliker, and more recently more fully investigated by myself in *Tylosurus*, *Hemirhamphus*, and *Chirostoma*, consisting of a garniture of fine filaments which partially clothe the surface of the membrane. These filaments are developed within the ovarian follicle as processes of the envelope of the egg, around which they are closely coiled until brought into contact with water. The peculiar mucus which hardens under water is probably also developed as a secretion of the ovarian follicle in most cases; in others there doubtless exist glands which secrete this material, in the same manner as we find a special secretory sack in the male of *Apeltes*, from which the material for the fibers is derived with which the animal binds together the parts of its nest.

As far as my own investigations enable me to judge, the history of the process of the maturation of the ova of bony fishes in general is very similar, but there are modifications of the process, the nature of which can only be ascertained through a study of the growing ovaries of representatives of the various families known to the ichthyologist. It is probable that even this will not suffice, for the most unexpected peculiarities are found to be very characteristic of the eggs of a species closely related to some other. As an example of this, the egg of the shad may be mentioned as differing very greatly from the egg of the herring, in that the former has a very much more spacious breathing chamber surrounding the vitellus or yelk than the latter. It is not adhesive, a characteristic by which it may be again distinguished from the egg of the herring. Such peculiarities are no doubt related to some

special physiological characteristics, about which it is very important that practical fish-culturists should be informed, in order that they may be enabled to handle the eggs intelligently.

The existence of a second nuclear body in immature fish ova has been asserted by Balbiani and Van Bambeke. Balbiani speaks of it as the *vésicule embryogène*, a name given to it by Milne-Edwards, and he figures it in the immature ovarian eggs of *Pleuronectes limanda*, lodged in a depression at one side of the vitellus. He has also detected it in the unripe ova of the carp, pike, perch, and *Cottus lævigatus*, by the use of acetic acid. The writer has not seen this accessory vitelline nucleus in the ovarian eggs of any species studied by him, although working with the same reagent; there is a possibility, however, that it may have been overlooked. This body corresponds to the accessory nucleus originally discovered by Von Wittich in 1845, in the eggs of spiders, and called a vitelline nucleus (*Dotter-kern*), by Carus in 1850, which name is in general use by German investigators; Van Bambeke speaks of it as the nucleus of Balbiani. Reiterated attempts at a demonstration of this accessory nucleus have failed with me; I have seen what might be taken for it, but would not venture to assert that what I saw was normally characteristic of young ova, such as some of the investigators alluded to above have evidently used. The immature ova of *Anguilla vulgaris* have given me good opportunities to study the structure of the nucleus or germinal vesicle, in which, however, I find nothing very different from what has already been described by Beale, Rauber, and others. The nucleoli adherent to the wall of the germinative vesicle in the ovi. cell of the eel are, I find, very numerous. Amœboid movements and changes of form of the nucleolus or germinative spot have been described by Eimer* in the immature eggs of *Silurus glanis* and the carp. In these the germinative spot, which is included by the germinative vesicle, underwent great changes of shape in comparatively rapid succession, throwing out prolongations in different directions, and then withdrawing them again, like an *Amœba*. The germinative spots of the immature ova of *Gambusia* show these movements. The germinative vesicle itself, in fact, may undergo slight spontaneous changes of form, and in stained preparations, especially where safranin has been used, a considerable variation of form may be noted, and evidence of a thick nuclear wall also becomes pretty clear in many immature ova. Nuclear changes are, however, now known to be very generally manifested by all kinds of cells.

Recently a more careful study of the germinative vesicle of ova in general has revealed the fact that its substance is traversed by granular threads, which anastomose with each other and tend to connect the walls of the vesicle and the germinative spot or spots together, just as has been found to be the case with ordinary cells of all kinds where the wall of the nucleus and the globular nucleoli are found to be joined

***Arch. f. Mik. Anat.*, XI, 1875, pp. 325–328.

in this manner. This structure has been called the nuclear net work or reticulum. Such reticuli have been observed in the germinative vesicles of the eggs of *Hydra*, star-fishes, sea-urchins, and fresh-water mussels; by the writer in the eggs of the clam, oyster, common slipper limpet, and gar-pike; by Van Beneden in the ovarian eggs of bats; by Balfour in the ovarian eggs of sharks; by Rauber in the ova of osseous fishes; so that their occurrence is probably almost universal throughout the animal kingdom. Not only are egg-cells found to have such reticuli developed in their nuclei, but they are also found developed in white blood corpuscles and many other kinds of histological elements. The extraordinary similarity in the character of many of these reticuli is very striking, and argues for the existence of a similar cause in their production in the diverse forms in which they occur. In Flemming's elaborate researches nuclear forms of such complexity have been described as to put one's credulity to the test, but more recent investigations of my own with his methods have convinced me that such structures do exist, and that we have hitherto missed them only for want of the means of demonstration.

The fate of the germinative vesicle when the egg has reached maturity is still involved in some obscurity as far as concerns the eggs of fishes. That it disappears before the egg leaves the follicle in which it was developed there can be but little doubt, for as soon as the ripe eggs have fallen into the intraovarian cavity they are found to have lost all trace of the conspicuous germinative vesicle or nucleus which was so characteristic of them in their immature condition, and to have acquired a transparency and homogeneity in which no trace of a nuclear body can be made out with the most cautious use of reagents. In this, Hoffmann has been more fortunate than myself. This is conspicuously the character of the ripe egg of the cod. When first removed from the ovary, the vitelline membrane is somewhat lax, but as soon as it is placed in water it slowly absorbs it through the micropyle, and soon becomes tense from an imbibition of that fluid, which occupies a space all around the vitellus between it and the vitelline membrane. Impregnation seems to be necessary in some species before any water can be absorbed; this is especially the case with the ova of the shad, but is in a lesser degree necessary in the case of the cod. Practically, these facts are of great use, as in the instance of the shad, where the egg acquires several times its original dimensions, and when impregnated and "water-swollen" it is said that the eggs have "risen," which may be taken as a very sure indication of the fact that impregnation has taken place. The same eggs unimpregnated will not become "water-swollen" until a much longer time has elapsed, a very large proportion of them not at all, which shows the remarkable influence exerted by the entrance of the spermatozoa through the micropyle upon the power of the egg membrane to absorb water. It would appear as if the spermatozoön, in making its entry, had opened a passage-way for the water.

Such an effect upon the micropyle is conceivable, though we are at a loss to understand the function of the pore-canals, should it be true that the entrance of the spermatozoön would cause the micropyle to remain permanently open. Johannes Müller believed that he had demonstrated that they were tubes, and with careful manipulation it has appeared to the writer that he could see through the individual canals when a piece of canaliculated egg membrane was placed flatwise under the microscope and viewed with a high power of good definition. This is also the opinion of Allen Thomson, expressed in the article "Ovum" in Todd and Bowman's Cyclopediæ of Anatomy and Physiology.

The imbibition of water by an unimpregnated fish egg appears to be largely due to osmotic action. If an impregnated egg is placed in a fluid having a great affinity for water, such as alcohol or glycerine, the membrane tends to collapse at first, owing to the rapid extraction of the water from the cavity of the enveloping membrane; as soon, however, as the balance of osmotic action is restored and the contents of the envelope become as dense as the surrounding fluid, the membrane becomes full and tense as at first. This tendency of the membrane to reassume the tense or full condition is doubtless due to the capillary action of the pore canals of the membrane, where such exist.

In the freshly laid unimpregnated ova of both the cod and the shad one may look in vain for a germinal disk such as had been described by various authors in the freshly laid eggs of other species of fishes. Even after the egg of the cod has lain in water for some hours there is very little change in the relation of the germinal matter and the yelk. The former covers the yelk as a thin layer of absolutely uniform thickness, as shown in Fig. 1, and differs from the yelk only in color, being yellowish, tending towards amber in tint. The distinctness of this external germinal or cortical layer of authors in the cod's egg is more decided than in any Teleostean ovum which it has been my privilege to study. The germinal protoplasm shows a double contour under the microscope outside of the yelk, and is as sharply limited as if it were an independent envelope. This germinal layer is further distinguished from the yelk which it incloses in that it has refringent globules or vesicles imbedded in its substance, as shown in Fig. 1. In Figs. 2 and 3 these vesicles are shown more magnified, and are seen gathered together in clusters. In Fig. 4 a portion of the germinal layer is shown in optic section, and represents the vesicles lying next its outer surface. The disappearance of these vesicles is comparatively rapid, and appears to be effected in the following manner: Those in close proximity to each other coalesce and form larger vesicles, and are thus reduced in number, and finally disappear altogether by rupturing their outer walls next the outer surface of the germinal layer, possibly expelling their contents into the respiratory or breathing chamber surrounding the vitellus. This view is only theoretical, however, as the writer failed to discover what became of them by actual observation. As long as the egg was

not brought in contact with the male spermatic fluid the outer pellicle of germinal matter retained the disposition shown in Fig. 1, with its included vesicles, but as soon as the egg was fertilized, or shortly thereafter, the vesicles were seen to grow larger and less numerous, because the clusters were coalescing and apparently being expelled from the germinal matter. So great was the influence of the presence of spermatozoa that those eggs in contact with them began to change almost immediately, while unfertilized ova retained their vesiculated germinal layer unchanged for four hours after their removal from the ovary of the parent fish.

The disappearance of the vesicles above described was therefore an indication of the fact that impregnation had taken place.

Since the foregoing was written the writer has observed similar phenomena in the ova of *Tylosurus*, *Elacate*, and *Cybium*, in all of which the development of the germinal disk is effected by the aggregation of the germinal pellicle at one pole to form the germinal disk. The same is true of the eggs of the branch herring, *Pomolobus vernalis*, and the shad. The germinal pellicle is, moreover, part and parcel of the intermediary layer of Van Bambeke, *couche hæmatogéne* of Vogt, and parablast of Klein; the germ disk and the yelk hypoblast are both derived from it, as we shall learn farther on. It includes both of the latter, and the names bestowed upon the cortical layer by different embryologists simply serve to denominate what was at first a part of the germinal matter of the egg and afterwards becomes the envelope of the yelk.

Balbiani states that Agassiz and Burnett recognized evident traces of segmentation in the unimpregnated eggs of certain American fishes of the cod family. As the writer has been unable to find the original of this statement, it will be of little use to discuss the matter in the absence of all evidence to confirm the observation, for, as not even a germinal disk was developed in unimpregnated eggs of the cod after four hours had elapsed, in impregnated ova it was appreciably developed one and a half hours afterwards; it follows that it is not probable that any true cleavage of the germinal disk of this species ever takes place without the influence of the spermatic particle.

That the germinal disk is formed independently of the influence of the spermatozoön in many other species there cannot, however, be the slightest doubt. I have witnessed this phenomenon in the eggs of *Chirostoma*, *Morone*, *Parephippus*, and *Ceratacanthus*, while it is known to take place in many other species investigated by European authors, but the disk appears in some cases at least to have been differentiated before it leaves the intraovarian cavity, as in some *Salmonidæ*, for example.

In order to ascertain more definitely the nature of the minute vesicles inclosed in the germinal layer, a number of unimpregnated ova were placed in dilute acetic acid, which had the effect of freeing the outer germinal pellicle from the yelk. The pellicle was then carefully removed, and stained with hæmatoxylon and mounted; the protoplasm interven-

ing between the vesicles was the only portion which would stain, the vesicles remaining perfectly transparent. From this it was concluded that the contents of the vesicles were not protoplasmic or nuclear, but some indifferent fluid. When immersed in alcohol or ether no change was noticed, so that it was highly improbable that the vesicular contents were oily.

His has observed that the oil globules of the salmon egg are surrounded by an albuminous envelope; this is probably only a continuation of the protoplasm of the germinal layer, as the oil always has a superficial position in these forms and is not deeply imbedded in the yelk, as in *Brosmius*, *Cybium*, *Parephippus*, and *Elacate*. Meischer has also shown that His is wrong in his belief that the rose-colored oil of the salmon egg is composed of lecithin, but is an oil not coagulable at 100° C. nor under the influence of concentrated acids, insoluble in alkalis, very soluble in ether and alcohol, and is invariably removed from ova preserved in a strong solution of the latter. If the egg has been previously hardened in chromic acid, and sections are prepared, I find that the places formerly occupied by the oil spheres are shown as circular openings around the edge of the section next the yelk envelope. The oil is almost instantly blackened by osmic acid; in the unchanged state it swims upon the surface of the water when a fresh egg is crushed and the oil allowed to escape.

3.—Fate of the germinative vesicle.

The observer sought in vain in these stained preparations of the ripe unimpregnated eggs for the germinative vesicle, and equally fruitless were his endeavors to discover this structure immersed in the yelk beneath the germinal disk after the latter had been formed. It is believed, therefore, that it has been broken up before the egg has escaped from its follicle in the ovary, and that its remains have rearranged themselves in some way in connection with the germinal matter. No advance of the germinative vesicle towards the periphery of the egg was ever observed in the immature egg, or in those nearly mature, so that it is surmised that the process of breaking up takes place with comparative rapidity. Kupffer's search for the germinative vesicle of the ovum of the herring was, according to his own account, as fruitless as my own with the cod's egg. Like the ova of birds, those of fishes seem to lose their germinative vesicle before they leave the follicle in which they were developed. It is a most remarkable fact that in some types, mollusks, *e. g.*, the germinative vesicle—egg nucleus—should persist in a central position after maturation, and in others, as, for example, in the ova of Elasmobranchs, Teleosts, and *Aves*, it disappears or is metamorphosed by the time of maturity and before the egg has left its parent follicle. Again, it is equally remarkable that in some forms the *polar cells* are developed independently of impregnation, while in others the nuclear metamorphosis attendant upon the development of the polar

cells never precedes the conjugation of the egg and the spermatozöon, as appears to be the case with the eggs of *Ostrea virginica* and *O. angulata.* The account given by Œllacher of the disappearance of the germinative vesicle in the egg of the trout will evidently not hold for that of the cod, where there is no germinal disk developed at the time of the maturation of the egg. Here, as in the shad, the vesicle has already disappeared as such while the egg was still within the follicle, but my efforts to study the metamorphosis of the germinative vesicle in ova of varying grades of maturity in the lobules of the ovary led me to no definite or valuable conclusions. The ripe eggs lose the whitish color of the less mature ova which still have the germinative vesicle imbedded in their centers.

Œllacher has given the following account of the disappearance of the germinative vesicle in the egg of the trout: "The germinal vesicle approaches the periphery of the egg and is enveloped by the germinal matter while still within the follicle. The germinal vesicle of the trout egg recently escaped from the follicle is, according to my observations, wholly eliminated. I have described the whole series of phenomena which occur during this elimination in Max Schultze's *Archiv für mikroskopische Anatomie*, Vol. VIII, and figured in different phases of the same. The process is briefly as follows: In the egg recently freed from its follicle the germinal disk is aggregated at a certain time in a depression on the surface of the yelk sphere. In it the germinal vesicle is embedded, opening on its surface by a fine pore. The thick wall of the vesicle, which is traversed by fine pore canals, and in close contact with the germinal matter, begins to manifest contractions, is ruptured, and is finally spread out upon the surface of the germ in a circular form. By this means the contents of the germinative vesicle, in the form of a finely granular spherule, are eliminated from the germ. I once observed that the contents of the germinative vesicle were divided into two unequal spheres."* Œllacher then figures the case of a trout egg in which the germinal vesicle has divided, and has been expelled from the germinal disk as two dissimilar globular bodies. These two bodies may well be the two polar cells of other embryological writers. It seems to me highly improbable that an actual elimination and dissolution of a portion of the substance of the egg takes place, such as is here described. We will describe further along what may possibly be regarded as polar cells in the cod's egg. The early contractions of the germ disk of the trout are well described by Œllacher, and seem to be usually met with by investigators who have studied the development of fishes. The polar cells of the shad egg, or what I at one time regarded as such, I now think are probably a result of abnormal development, and not to be considered in this connection.

Salensky,† in his preliminary account of the development of the ster-

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* *Zeitsch. f. wiss. Zoologie*, XXII, 1872, pp. 406–407.

† *Zoologischer Anzeiger*, I, 1878, pp. 243–244.

let, has given the following account of the changes undergone by the germinative vesicle:

"The germinal vesicle is embedded in the germ disk, and is so large that it may be seen with the naked eye; it is without a wall, and consists of a glairy substance, which hardens in spirits, and is only separated from the surrounding plasma of the germ by a denser layer of protoleucite [germinal protoplasm].

"During the first hours after oviposition one can no longer distinguish the germinal vesicle; and in its place a number of small islands may be observed, consisting of more transparent matter, which are scattered through the germinal mass, and which in their structure are quite similar to the germinal vesicle. The identity of the substance of these islands with that of the germinal vesicle indicates that the latter, even before impregnation, breaks up into a number of parts; a phenomenon which is analogous to what occurs in other animals, as in echinoderms, for example, as described by several investigators (O. Hertwig and Fol).

"Impregnation is indicated by the appearance of a clearer discoidal mass at the upper pole of the egg, and consists of a transparent, almost homogeneous substance, which corresponds to the veil-like body of the amphibian ovum described by Hertwig. We may retain the name proposed by Hertwig for this structure. On the surface of the veil-like body a vast number of spermatozoa may be noted, with their heads directed to the outside and their tails in the opposite direction. The veil-like body lies so closely against the surface of the egg that it is difficult to make out a separation between them; it attains its greatest thickness at the upper pole of the egg, and grows downwards in the form of a strand into the germinal mass; towards its margin the veil-like body gradually thins out. The surface of the germ at the time of impregnation appears to be very strongly pigmented. At the upper pole of the egg this pigmentation is most marked. The pigmented mass, which appears in that position as an elevation, depends inwards into the germ and forms a band, which, from its analogy to that described in the ova of amphibia by O. Hertwig and Bambeke, may also be called the pigmented tract (*Pigmentstrasse*). It is very possible that this indicates the pathway by which the spermatozoa penetrate the egg.

"The entrance of the spermatozoa I could not observe. For the observation of this phenomenon the eggs of the sterlet are not well adapted. In the earliest stages observed by me I found a clear spot at the lower end of the pigmented tract which was evidently nothing more than a portion of the future segmentation nucleus, and therefore the male pronucleus. This body was without a wall, and consisted of a finely granular, transparent substance, and was covered above by pigment granules. The formation of the female pronucleus (*Eikernes*, O. Hertwig) occurs at the expense of the islands already alluded to, one

of which approaches the male pronucleus, becomes more nearly round, and finally assumes the ovoidal form of a nucleus. In the course of further development the two pronuclei approach each other more closely, and finally blend together into one nucleus, which represents that of the first cleavage, and in its histological characters is perfectly like the pronuclei; it is without a wall, and consists of finely granular, almost homogeneous matter."

Schenk's account of the metamorphosis of the germinal vesicle of the ray is somewhat like that of Œllacher's regarding the trout, except that he does not state that it is eliminated in a similar manner. Alex. Schultz asserts that the appearances seen by Schenk are the result of the action of reagents.*

4.—Development of the germinal disk.

As already remarked, the vitellus of the cod's egg is composed of a thin external layer or pellicle of germinal matter, which incloses the yelk substance, which forms by far the largest proportion of the whole vitelline mass. The outer pellicle (*Dotterhaut* of Œllacher; *couche intermédiaire*, Van Bambeke) may be regarded as the *protoplasm* from which the germ is formed, while the contained yelk, which is broken down into leucocytes during development and later embryonic growth, is the *deutoplasm.* These structures are the homologues of similar parts in other Teleostean eggs as well as in those of the *Chondrostei*, or sturgeons, as we perceive by the description of the ova of the latter by Salensky. The layer *pr* and the contained mass *d* of Fig. 1, pl. I, correspond to these two elementary portions of the vitellus of the cod's egg.

The formation of the germinal disk of the cod by a kind of amœboid migration of the peripheral germinal matter towards the lower pole of the egg is one of the most remarkable phenomena in the history of the development of Teleostean eggs which has hitherto been recorded. The amœboid movements which accompany the development of the disk are most striking, and cannot fail to arrest the attention of the observer, in that as soon as a perceptible thickening or accumulation of germinal matter has gathered at the lower pole, the germinal protoplasm manifests active changes of form, due to its contractility. These pass over the incipient disk as waves of contraction, and accompany the process of development of the disk long before any sign of segmentation has

* In this connection I may remark that chromic acid, followed by alcohol, or the first alone, will sometimes produce changes in the yelks of fish ova of a very remarkable character. In illustration, I recall the alterations so induced in the yelks of the eggs of the shad. Sometimes the effect produced by the shrinking and coagulation of the deutoplasm is to develop a complex system of anastomosing canals and spaces, which at first look like as if they were truly normal features in sections. Further investigation has convinced me that these tubular cavities are purely the result of the action of chromic acid upon the proteids of the yelk. Doubtless, structures of this kind have misled other investigators, judging from observations which are upon record.

been manifested. With this accumulation of the germinal matter the corresponding pole of the egg also becomes heavier.

In its singular progressive movement the germinal layer is observed to become thicker at the lower than at the upper pole of the egg, and to bulge upwards into convex elevations on its inner surface next the yelk. This migration proceeds until the yelk at the upper pole is almost exposed, as in Fig. 6, which shows the relation of the germinal matter to the yelk one and a half hours after impregnation. While there are no oil spheres present to buoy up the eggs, as in the mackerel and moon-fish, the specific gravity of the germinal matter is greater than that of the yelk, so that it always assumes a position on the lower side of the yelk. Should the egg be turned round so as to bring the disk uppermost, the yelk will be gradually turned by the gravity of the disk until the latter regains its nethermost position. During its migration the germinal protoplasm eventually arranges itself in radiating bands, which sometimes anastomose, and all trend towards and join the edge of the incipient disk below. Later these bands develop nodes or enlargements, *prn*, along their courses, as shown in Fig. 7, and pour their substance into the disk, which is now defined three hours and forty minutes after impregnation. If a granule in one of these bands is watched for a time it will be noticed that it exhibits a more or less decided progressive movement.

At the time the disk is defined its inner surface at first presents irregular rounded elevations, which gradually subside, when the under side of the disk becomes flat. Then the outer surface of the disk is elevated into one or more large rounded, prominences, which in like manner eventually disappear. These are some of the amœbal phenomena already alluded to.

It is very important for us to make a distinction here between the mode of formation of the germinal disk of the cod and that of the Clupeoids, as worked out by Kupffer and myself, and of *Tinca*, as described by Van Bambeke. It would appear that we concur in the opinion that in the latter more or less protoplasm destined for the development of the germinal disk is derived from the center of the vitellus, into which, as may be seen in the ova of *Alosa*, *Clupea*, and *Pomolobus*, the external germinal layer sends processes which in the shad and branch herring look like hyaline roots passing down amongst the yelk spheres. At a later stage of development this arrangement seems to disappear, and the yelk spheres, although still evidently involved in a meshwork of germinal matter, do not have the same amount of the latter insinuated between them as at first in the vicinity of the developing germinal disk. On the other hand, in the eggs of *Gadus*, *Tylosurus*, *Cybium*, *Elacate*, and *Parephippus*, the germinal matter forms a distinct outer coating over the vitellus, and these forms do not have any distinctly marked yelk spheres, as in *Alosa*, involved in germinal protoplasm, except in the case of *Elacate*, where the yelk spheres are very

large and few in number. What is meant here by the term yelk spheres must also be explained. We denominate as yelk spheres those large, finely granular masses of protoplasm which are involved in a delicate matrix of germinal protoplasm. The ultimate granules or spherules which compose these spheres or yelk masses are altogether different, vastly more minute, and are the same as what we have called yelk spherules and granules. The large yelk masses are very clearly seen in the shad's egg, that of the herring, and in *Elacate*, but not so clearly in any other forms known to me. In many types the yelk is almost homogeneous under a low power. In Cyprinoids it is finely granular, and again wholly different from what is seen in the eggs of Clupeoids and Gadoids. These distinctions are important, and not less so is the distinction drawn between the mode of formation of the germinal disk of the Gadoids and Clupeoids. The germ disk of Gadus is wholly developed from the external germinal layer of the vitellus, that of the Clupeoids is apparently not entirely so formed, but derives part of its substance from the protoplasmic matrix involving the large yelk spheres or masses below it.

The germinal pellicle, cortical layer, has certain common characters in all the forms, however; these are its superficial position and the vesicular or refringent bodies it incloses prior to the development of the disk. In the eggs of the shad and of the herring the cortical or germinal layer contains large refringent bodies, different from the vesicles which occur in the same layer in the ova of *Gadus*, *Tylosurus*, and *Cybium*, in the last of which I have watched their slow disappearance and apparent absorption into the surrounding germinal plasma. In this process they become gradually smaller and finally disappear under the influence of impregnation. It would seem as if these refringent structures were somewhat similar to those seen in the germ of *Acipenser ruthenus*, and described as *islands* by Salensky. In *Clupea* and *Alosa*, as the peripheral germinal matter is gradually gathered into a depressed, somewhat conical germinal disk, the refringent globules or spherules which were originally distributed over the whole vitellus become less numerous and mostly disappear, except over a portion of the vitelline surface and in spots usually near the margin of the disk. After the disk has segmented into a large number of cells and advanced somewhat beyond the morula stage, these refringent spherules have disappeared entirely. The space figured underneath the germinal disk in the yelk of the egg of *Clupea harengus* by Kupffer is probably a product of the hardening reagents used, and is not to be regarded as a *latebra* in the sense of the structure of that name found in the ovum of birds. Actual sections of several species of fishes of very early stages of development have served to convince me of the correctness of this interpretation. Germinal matter which does not take part in segmentation lies below the disk, as shown by Œllacher, and extends over the vitellus as an almost structureless membrane, *Dotterhaut* of Œllacher. It is this membrane which protects the vitellus and forms

a coating over the yelk while the egg is developing within its membrane or capsule, and even includes the yelk after the blastoderm has closed over it. This yelk membrane or pellicle derived from the germinal matter forms the floor of the segmentation cavity. In the substance of the membrane free nuclei also develop; these doubtless contribute by a process of intussusception to the formation of hypoblastic structures at an early stage of development, but later these nuclei appear to give origin only to blood cells, mainly in the form of leucocytes, except in the case of *Tylosurus*, where the blood cells of the early stages are colorless, but hæmoglobin is soon developed, and finally, it would appear, concurrently with their free germination from the membrane they are already colored. The free nuclei are most numerously imbedded in the portion of the yelk membrane or hypoblast in the neighborhood of the heart, near the head, and at the anterior portion of the yelk-sack.

5.—Impregnation of the egg.

Of the history of this process in the Teleostean egg we as yet possess very few trustworthy observations, except those of C. K. Hoffmann. This is in part due to the difficulty attending its study in an egg of such a disproportionately large size as that of the fish with its large yelk, and no observations have yet been made upon this point with such success as upon the eggs of mollusks and echinoderms, as, *e. g.*, *Limax campestris*, by E. L. Mark; *Asterias glacialis*, by Fol; and *Toxopneustes variegatus*, by Selenka. Hertwig, Flemming, and Bambeke have also contributed essentially to our knowledge of the process of impregnation, the former and latter especially in relation to what occurs in the amphibian ovum. Almost all observers seem to be agreed that a single spermatozoön only is requisite. This enters the egg either through a penetrable membrane or through a micropyle, and blends at once with the plasma of the egg, producing in this process of coalescence a clear space, surrounded by granular rays in the vicinity, which has been designated the male pronucleus. This male pronucleus then blends with the female pronucleus to form the first segmentation nucleus, but the origin of the female pronucleus, as described by Fol, is somewhat complicated. It is derived from the germinative vesicle by a complex metamorphosis of the latter. The following is the series of events attending impregnation and the order of their occurrence, essentially, as observed by Fol and summarized by Balfour:

"1. Transportation of the germinal vesicle to the surface of the egg.

"2. Absorption of the membrane of the germinal vesicle and metamorphosis of the germinal spot and nuclear reticulum.

"3. Assumption of a spindle character by the remains of the germinal vesicle, these remains being probably in part formed from the germinal spot.

"4. Entrance of one end of the spindle into a protoplasmic prominence at the surface of the egg.

"5. Division of the spindle into two halves, one remaining in the egg, the other in the prominence; the prominence becoming at the same time nearly constricted off from the egg as a polar cell.

"6. The formation of a second polar cell in the same manner as the first, part of the spindle still remaining in the egg.

"7. Conversion of the part of the spindle remaining in the egg into a nucleus—the female pronucleus.

"8. Transportation of the female pronucleus towards the center of the egg.

"9. Entrance of a single spermatozoön into the egg.

"10. Conversion of the head of the spermatozoön into a nucleus—the male pronucleus.

"11. Appearance of radial striæ round the male pronucleus, which gradually travels towards the female pronucleus.

"12. Fusion of male and female pronuclei to form the first segmentation nucleus."

The foregoing account is essentially the sequence of events as observed by Fol in *Asterias glacialis*. This series of events evidently does not hold for all forms. Thus, in *Hirudinea*, *Mollusca*, and *Nematoidea* impregnation takes place normally before the extrusion of the polar bodies is completed (Balfour), so that the event which stands as ninth in the preceding scheme would actually stand first, as in the case of the egg of *Ostrea*, where no disposition is manifested to extrude polar globules until the ova are brought into contact with the spermatozoa. In the case of the lamprey, Kupffer and Benecke have shown that only one spermatozoön enters the egg, but that others pass through the vitelline membrane, and are taken into a peculiar protoplasmic protuberance of the ovum which appears after impregnation. In ova of *Ostrea virginica* which have been killed and hardened in osmic acid the pellucid tract which penetrates the egg for some distance in the vicinity of the polar globules probably represents the axis of the amphiaster formed at the time of the development of those bodies. I am well assured of the fact that no tendency toward a reorganization of the centrally placed nucleus of the mature egg of the oyster is ever manifested until it is brought into contact with spermatozoa. The egg of the osseous fish is scarcely referrible to either of the foregoing categories; it has lost the germinal vesicle as a central structure before it leaves the parent follicle, and coincident with the development of the germinal pellicle or germinal protoplasm which covers the yelk or deutoplasm, its substance has probably been mostly transferred to that layer. As we now know that the germ disk is formed at the time of impregnation or independently of it, it is to be supposed that in this process the germinative vesicle or its remains may not improbably undergo a complex metamorphosis. Although I have not yet met with anything that I could regard as undoubted polar cells, a minute prominence occurs on the disk of the cod which may be regarded as such, or as an apparatus for the

reception of the spermatozoön, such as has been described by Kupffer and Benecke in the egg of the lamprey. This structure is represented in Fig. 7, Pl. I, at *pp.* in an egg of the cod, in which the formation of the germinal disk has not yet been completed. Repeated observation convinced me that I was not looking at an accidental feature, but that it was constant during this and somewhat later stages of development antecedent to segmentation. The actual ingress of the spermatozoön into the ovum I have never witnessed, although the cod's egg is one of the best adapted of all fish ova for this purpose on account of its transparency and small size. If Fol's compressor is used, experiments may be very readily carried out undei the microscope, and if the upper and lower plates of the compressor are kept far enough apart so as just to allow the eggs to remain free and mobile within a few drops of water, encircled by a ring of block tin or hard rubber, clamped by the cover, the eggs will always arrange themselves in one position, with the germinal disk downwards and the yelk uppermost. This peculiarity enables one to see only the lower face of the disk through the large transparent yelk above it when the tube of the microscope is placed vertically, or its edge, or in optic section, when the tube of the microscope is placed horizontally, with the stage and compressor upright. To see the upper surface of the germinal disk of the live egg it is most convenient, in fact necessary, to have an inverting prism attached to the microscope, into the mounting of which the objectives may be screwed, so as to view the eggs from below. Nachet's inverted microscope, used in chemical investigations, would answer well for this purpose. The sketches which I have made were obtained from living eggs treated in this way, without compression while confined within the area of a hard rubber or metal ring, which served to hold the water and eggs in place when the cover of the compressor was screwed down. Attempts made to witness the entrance of the spermatozoa by the help of the above described apparatus, using very dilute mixtures of milt with water, were not successful. The proper mode of procedure, in order to demonstrate the changes by histological methods, would be to take a batch of ova fresh from the ovary and divide them into two lots. Impregnate the one lot and allow the other to remain unimpregnated. Then take of both a series of specimens at intervals of two or three minutes and place them in a dilute chromic acid solution to fix the nuclear and other protoplasmic changes, so as to afterwards facilitate staining and the preparation of sections, and the satisfactory study of all the changes which the nuclear matter of the germ has undergone until the time of the first segmentation. A similar series of the unimpregnated ova would throw some light upon the history of the process of the migration of the nucleus from the center of the egg, if taken in connection with the investigation of the mature and functionally active ovary with its products in different conditions of maturity.

The complete disappearance of the germinative vesicle from ova in

general previous to impregnation, had, for many years, received the assent of many distinguished investigators, though not a few still hold to the belief that it did not wholly disappear. The latter view is the one now generally accepted by embryologists and rests upon several series of investigations carried out by several observers with the greatest care. Notwithstanding this some very eminent investigators still hold to their belief in the total disappearance of the nucleus of the ovum, and they base upon this supposed fact a very weighty argument for their favorite hypothesis, which demands that all eggs during their development shall pass through the moneron or non-nucleated stage of development, in accordance with the doctrine that the development of the individual must briefly recapitulate the development or evolution in time of the race to which it belongs. This grand generalization properly conceived is truly important, but its more recent defenders have overstepped the bounds of legitimate deduction and induction in their efforts to establish a consistent theory of animal evolution, in that later researches have shown that the *monerula* stage of animal development is not yet demonstrated.

Latterly it has been affirmed by Strasburger* that not only is *omnis cellula e cellula* true, but that the truth of *omnis nucleus e nucleo* is nearly equally well established. The chaotic *monera* and *urschleim* of the Haeckelians are justifiable only if they carry no grievous errors and mischief into the sacred realm of science. The extensive discussion of such points to the exclusion of the true methods of investigation has called for several digests of the existing state of the facts in the case, one of the best of which is that given by Mr. C. O. Whitman, in his Embryology of Clepsine.† Modern histology, that is to say, what we have learned to know of cell development within the past decade, discountenances most emphatically the doctrine of the existence of *structureless* cells devoid of nuclei or nuclear matter. In fact, in addition to the dictum of Strasburger, we owe it largely to Professor Flemming that we have proof of the exceedingly complex metamorphosis of nuclei in the most ordinary processes of growth. The dividing line between the phenomena of growth, cell development, and the early phases of embryonic and embryogenetic development is certainly not as easily made out in many cases as might be supposed, and if there were no other argument against the monerula hypothesis, the facts of embryology and histology alone would be sufficient to impel a candid person to at least suspend judgment for the present.

Recent investigations upon the impregnation of the eggs of the lamprey (*Petromyzon*) by Kupffer and Benecke show that there are two polar cells extruded from the germ ; one is formed previous to, the other

* In an address delivered before the congress of German naturalists, at Danzig. Published in French in the *Revue Internationale des Sciences Biologiques*, IV, No. 3, 1881.

† Quarterly Journal of Microscopical Science, July, 1878.

after the entrance of the single spermatozoön which effects the fertilization of the egg. Beside these there is a polar process, *zapfen*, which originates from the middle of the germinal disk as a hyaline protoplasmic band (*axenstrang*, Calberla), drawn out by adhesion to the inner surface of the zona radiata from the center of the germinal disk when the zona is lifted up from the latter by the imbibition of the water drawn in through the micropyle or pore canals. Through this process a single effective spermatozoön makes it way into the vitellus, when the hyaline process is withdrawn; a number of spermatozoa may enter the egg through the micropyle and be enveloped by the hyaline process, but they take no share in the impregnation. Calberla, on the other hand, asserts that but one spermatozoön enters the micropyle and that the tail is left behind, closing up the opening of the latter. In this Calberla agrees with Fol's description of the entrance of the spermatozoön into the egg of the star-fish. Scott says he has seen the second polar cell described by Kupffer and Benecke at the germinal pole of the egg. Calberla confirms almost fully the previous observations of A. Müller on the mode of impregnation of the eggs of the lamprey, but his views in regard to the fate of the germinative vesicle are not accepted by Scott.

The prominence which we noted on the germinal disk of the cod's egg is probably the representative of the extruded polar cells which have been derived from the germinative vesicle. It is not hyaline, as the polar process of the egg of the lamprey has been described to be, but is composed of granular protoplasm. The separate first polar cell adherent to the zona radiata of *Petromyzon*, upon its inner surface, is something very different from the polar prominence observed in the cod's egg, which reminds one in its main features of the polar cells of molluscan eggs. It is not so regular in form, however, as these, since it is scarcely ever, if approximately, the same shape in different eggs, often having a jagged appearance or with minute points projecting from the two principal portions. But since the writer did not succeed in witnessing the actual entrance of the spermatozoön into the egg on the breaking up of the germinal vesicle, the final interpretation of the nature of the prominence remains to be elaborated.

Prof. C. K. Hoffman, of Leyden, in the *Zoologischer Anzeiger* for 1880, pp. 607–610 and 629–634, gives the following as the result of his investigations, at the zoological station at Naples, of the early stages of development of *Scorpæna*, *Julis*, *Crenilabrus*, *Heliasis*, *Fierasfer*, *Syngnathus*, *Hippocampus*, *Gobius*, etc., but more especial attention was paid to the first two on account of the great transparency of the eggs of those genera.

"As to ovogenesis my observations fully agree with those of Waldeyer, Brock, and Kolessnikow; the primordial ova originate from tubular invaginations of the germinal epithelium of the ovary. The ovarian egg during its whole development is covered by a granulosa,

egg follicle, consisting of but a single layer of cells. At the time of maturation, a fatty metamorphosis of the cells of the granulosa takes place, which promotes the escape of the egg from the follicle. The micropyle is always an open pore; it has a very wide external opening and a very narrow inner one. The latter ends on an internal prominence of the egg-membrane, which is a zona radiata. The lumen of the internal micropylar opening is so constricted that not more than a single spermatozoön can pass through at one time, as was first observed by His in the salmon.

"It is well known that the eggs of many bony fishes adhere to fixed objects as soon as they fall into the sea-water. This is not always accomplished in the same way. In *Heliasis*, *Gobius*, *Blennius*, *Belone*, etc., this is accomplished by long filaments, excrescences of the zona radiata, which are not distributed over the whole of that structure, but which are found only on certain portions; viz, in the vicinity of the micropyle. In the herring and *Crenilabrus* the whole of the surface of the egg is covered with an adhesive material. In the case of all ova which attach themselves by these contrivances, the zona consists of two layers, an inner and an outer one, the latter being adhesive, and split off from the former to embrace the whole egg, or is developed in the form of fibers, processes, and similar appendages. In contrast with such forms, those ova which float or sink to the bottom, of their own weight, do not seem to have such a differentiation of the zona into two layers. It is highly probable that the zona is a secretion from the surface of the ovarian egg, and that it is to be regarded as a vitelline membrane.

"The primordial ova consist of a homogeneous mass, coagulable in acetic acid, when it becomes granular, and they inclose a large nucleus and a single large nucleolus. In very young ova, of which the contents are similar to the foregoing, several nucleoli may already be discerned in the nucleus. In the ova designed for the next brood, the yelk corpuscles are gradually developed, until they finally occupy the whole mass of the egg except the space taken up by the nucleus, and only the small spaces between the granules and corpuscles are filled up by the protoplasm still present. The yelk granules and corpuscles consequently appear to be developed at the cost of the contained protoplasm of the egg. The cells of the granulosa were never observed to give off protoplasmic processes passing inwards into the egg through the pore-canals.

"In the foregoing stage all of the eggs are dull and opaque; even the eggs of *Scorpæna*, *Julis*, *Serranus*, and *Fierasfer*, of crystalline transparency at maturity, pass through the same opaque stage of ovarian development. In the very large nucleus the nucleoli continue to multiply.

"Towards the time of maturity, the nucleus begins to move from its original central position to the periphery. During its change of position, the smooth, tightly distended nuclear membrane commences to

wrinkle, becomes gradually thinner, and finally disappears altogether; the already numerous nucleoli become still more so, but also smaller and smaller, until they are finally indistinguishable, so that one is obliged to conclude that they have been dissolved in the intranuclear fluid. Finally, the nucleus is brought to lie close against the zona radiata, as a wall-less, irregular, viscous, almost homogeneous mass; the intranuclear fluid in which the nucleoli have been dissolved now begins to mix with the egg contents. Accompanying this blending important changes occur, and, as a result of the process, the direction spindle, the nucleus, and the yelk are differentiated. In the pellucid ova of *Scorpæna* the yelk spherules are again broken down and the food-yelk then forms a clear, semi-fluid mass; in *Julis*, *Serranus*, and *Fierasfer*, the clear yelk also contains a large, shining oil-sphere; in *Crenilabrus* the yelk is not entirely pellucid, but contains some, not very numerous, yelk granules; in the herring and *Heliasis* the yelk contains a great number of yelk spherules, but which, in consequence of their larger size and less bright appearance, look very differently from the yelk spherules of the immature egg.

"The direction spindle [polar spindle] has its peripheral pole placed immediately against the inner opening of the micropyle. It is best seen in *Scorpæna*, in which it has a length of .025^{mm}, and a diameter of .0145^{mm}; its longitudinal axis forms an angle of 45° with that of the axis of the egg. It is less easily made out in *Julis*, while the eggs of *Crenilabrus*, *Heliasis*, *Gobius*, *Blennius*, *Belone*, *Clupea*, are too unsatisfactory and opaque as objects in which to seek for the direction spindle.

"The form of the germ in the mature ova taken from the females of different species, without being brought into contact with water, is very different. In *Julis* it surrounds, as a relatively thick layer, the entire yelk, and is thickest at the micropylar pole of the egg; in *Scorpæna* it covers in a cap-like manner the micropylar pole of the yelk where it is thickest, and becomes gradually thinner towards the equator, where it disappears almost wholly, but is continued over the opposite pole as a distinct but very thin layer. In the eggs of the herring and *Heliasis* it does not form a very thick stratum beneath the micropyle, and extends from this region as irregular thick and thin processes down amongst the yelk spheres of the whole egg. The direction spindle also is always imbedded in the germ disk. Kupffer's statement that the germ of the herring is developed under the influence of the sea-water and the sperm rests upon inaccurate observations; in the unimpregnated egg of the herring, as in *Heliasis*, the germinal matter still remains in great part strewn amongst the yelk spherules, as is apparently the case with all eggs in which the yelk does not consist of fluid material, but for the most part of larger and smaller yelk spherules.

"The fact that the yelk spherules of pelagic eggs should again be broken down and in mature eggs become clear and pellucid throughout must probably be regarded as a phenomenon of adaptation, the whole

developmental history agreeing fully with this interpretation, in that it is unusually rapid. For example, the eggs of *Julis* hatch in fifty-two hours, *Scorpæna* in fifty-eight hours, *Fierasfer* in fifty eight to sixty hours, without the slightest trace of pigment having yet appeared on the eyes, so that when the eggs are ready to hatch, they are still as transparent as at the time they were laid.

"I observed the following in watching the first phenomena of impregnation. In bony fishes, the first segmentation nucleus is formed as in numerous other animals, by the conjugation of two nuclei. One of these two nuclei is the egg nucleus (female pronucleus, *pronucléus femelle*), the other the spermatic nucleus (male pronucleus, *pronucléus mâle*). The conjugation of these two nuclei is best seen in the beautiful, pellucid ova of *Scorpæna* and *Julis*, as well as in the less transparent eggs of *Crenilabrus;* in the cases of other species of osseous fishes investigated (*Heliasis*, *Gobius*, *Clupea*, etc.), the ova are not clear enough to enable one to reach a conclusion in regard to this important point.

"As soon as a spermatozoön has penetrated so far into the micropylar canal that it reaches the germ disk, or perhaps the direction spindle itself, the first phenomena involving the spindle and germ appear in their order. Around the lower pole of the spindle there is formed a small, clear protoplasmic mass; whether a similar feature is developed at the upper pole of the spindle it is difficult to say, since this lies so close against the inner opening of the micropyle that it is not possible to be certain as to just what occurs here. The protoplasmic granules which are scattered irregularly through the egg gradually aggregate more and more around both poles of the spindle in distinct radial lines, especially around the small, clear protoplasmic area around the lower pole; shortly afterwards the development of the well-known caryolytic figures is accomplished forming the *amphiaster de rébut* of Fol. Scarcely have the radial figures [asters] become distinct, or at about the same time, it may be observed that the germ begins to contract [aggregate] at the micropylar pole. The first changes in the spindle now also begin, and it becomes at first somewhat shorter and thicker. The same remark applies also to the nuclear plate, when it again assumes its earlier form, and thereupon again elongates, becoming gradually thinner and thinner, before finally disappearing altogether. As soon as the spindle begins to elongate, the division of the nuclear plate occurs. The nucleus formed from the central half of the spindle is the egg-nucleus [female pronucleus]; that formed from the peripheral half of the spindle is the polar body, which in *Scorpæna*, *Julis*, and *Crenilabrus* escapes from the egg through the micropylar canal. Inasmuch as the division of the spindle begins as soon as the spermatozoön has penetrated deep enough into the micropylar canal to come into contact with the germ, and the lumen of the canal being so narrow that never more than a single spermatozoön can pass through it at one time, and the polar body being budded off at the same instant, as in *Scorpæna*, *Julis*, and *Crenilabrus*,

prevents the entrance of other spermatozoa. In the *three above-mentioned genera of osseous fishes more than one spermatozoön cannot therefore enter the egg.*

"Immediately below the inner opening of the micropyle, and at the point where the spermatozoön entered the germ and before the spindle has completely disappeared, there appears, although extremely small, yet plainly visible, a new aster or radial figure, and in its clear center a second small nucleus is developed—the male pronucleus. Around both nuclei the protoplasmic granules are arranged in sharply defined rays. Both nuclei then become gradually larger and larger, approach each other, to finally blend together to form the first segmentation nucleus. Before this conjugation takes place the germ has been completely aggregated by contractile movements of its substance at the micropylar pole of the egg. The eggs of *Scorpæna* and *Julis* only are adapted to the study of the phenomena here described. In the eggs of *Scorpæna* a very inconsiderable space is formed around the vitellus, between the latter and the yelk, which becomes noticeable only when the egg is getting ready to segment. The same remark applies to the eggs of *Julis*. In *Crenilabrus* the water space is, on the other hand, more spacious, but in that it is developed very late in the neighborhood of the inner micropylar opening, the germ remains in close contact with the inner opening of this canal, so that in these three genera of osseous fishes the polar body can be pushed out only through the canal, in that there is no space between the germ and the zona radiata. In other cases, as soon as the spermatozoön has come in contact with the germ a large paravitelline cavity or water space is formed, as in *Heliasis*, for example. In consequence of this, the polar body which is extruded cannot be thrust out into the micropylar canal, but remains within the paravitelline space. Since, in the cases of *Scorpæna*, *Julis*, and *Crenilabrus*, but one spermatozoön can enter the egg, it is highly probable, that the same is true of the ova of all osseous fishes, although it may not be possible at this moment to say with certainty at what time the entrance of other spermatozoa is interrupted. In those cases also in which a large water space is formed between the germ and micropyle, perhaps the tension of the zona radiata in such instances is effectual in closing the inner opening of the micropyle which ends on a papilliform internal prominence of the zona. In the water space within the zona I never saw any spermatozoa. The spermatozoa can enter the egg only through the micropyle. The phenomena which manifest themselves in mature eggs when simply placed in water without spermatozoa are very variable. Of one and the same lot of eggs of which a part were fertilized and developed regularly, the other part, after lying in water for twenty-four hours, did not show the slighest alteration; in others again, after four hours, the spindle had disappeared, the polar body was extruded, and the germ was as well developed as if the egg had been fertilized, with only this difference, that the germ was formed much more slowly than in the fertilized egg; in

other eggs of the same lot after four to six hours the spindle was still present, and the germ had aggregated and acquired an unusual thickness. Whether eggs in the two last mentioned conditions are still capable of impregnation I do not know, since in each instance the opportunity was wanting to make the test. In the cases in which the germ was developed after four hours and the polar body extruded, I never was certainly assured that I saw a nucleus—egg-nucleus. The aggregation of the germ, the extrusion of the polar body, and the disappearance of the spindle are phenomena which may occur independently of each other and of impregnation. Why a portion of one lot of eggs should remain unchanged in water without spermatozoa, while others pass through the changes above described, it is not easy to say; perhaps it is, that the most mature ova pass through the stages already described, while those not so mature remain unchanged, though capable of being impregnated."

6.—The origin of the yelk hypoblast.

This structure, in its relation to the genesis of the blood, is of the greatest interest physiologically, and the evidence of its true character, which has been gradually accumulating in my hands, is of the most conclusive nature. It has been named the *parablast* by Klein, *couche hæmatogène* by Vogt, *couche intermédiaire* by Van Bambeke, *couche corticale*, *germinal layer*, *germinal pellicle*, *Dotter-haut*, etc., but these terms are thoroughly synonymous, and their significance need not trouble us any further. I have followed its history through the later stages of development to its complete disappearance, and am delighted to be able to add the remarkable observations of Prof. C. K. Hoffmann* upon the origin of the free nuclei in it, as observed by him in *Scorpæna*. Ziegler has also studied its development in *Salmo salar*, so that the evidence as to the rôle it plays in development is almost complete. Further discussion of it in this essay will be postponed until I come to consider the history of the blood-vascular system of the yelk-sack of several forms. Under the head of the structure of the egg we have already described its main features as found in several species. Hoffmann's observations as to its early history are as follows, and were made upon the ova of *Scorpæna*, *Julis*, etc.:

"In respect to the segmentation I can communicate the following: While the male and female pronuclei are blending to form the first segmentation nucleus, the latter has already begun to again become spindle-shaped. The newly-formed spindle lies in the germ with its axis in conformity with the axis or diameter of the egg, and stands vertically against the end of the micropylar canal. The granules of the germ then group themselves in distinct rays around both poles of this spindle. The well-known caryokinetic phenomena then occur, which manifest themselves during each and every cleavage, and after

* *Zoologischer Anzeiger*, 1880, pp. 632–634.

some minutes the spindle-shaped stage has again vanished and two new nuclei have been formed, both of which lie in the plane of the axis or diameter of the egg. One of them lies at about half the depth of the axis of the germ, the other deeper and nearer the yelk. With the division of the first segmentation nucleus into two new nuclei, the consequent cleavage has led to the division of the egg into two very unequal portions, the upper and smaller lying near the micropyle and consisting of protoplasm, which, at the level of half the height of the axis of its substance, the germ, contains a nucleus; this portion I shall call the archiblast [the germinal disk of this essay], the other very much larger portion, the parablast [the yelk hypoblast; germinal layer]. The parablast consists indeed for the greater part of food-yelk, but it approaches in character the germ, the protoplasm in which lies a nucleus close to the yelk, and is continued over the whole yelk as a thin envelope. The archiblast [germinal disk] only segments; its nucleus is the parent of all the cleavage nuclei; the parablast [germinal layer] does not segment; nuclear division only takes place in it; it is developed into a multinucleolar cell.

"Before the separation of the archiblast from the parablast, each nucleus of both these parts has been transformed into a new caryokinetic figure or spindle, the position of the axes of which are at right angles to the axis or diameter of the egg. The spindle or caryokinetic figure formed by the nucleus of the archiblast (germinal disk) is a magnificent spectacle; that of the parablast is less distinct on account of its more central position. Before two new nuclei have been formed from the spindle in the archiblast the first segmentation furrow begins to divide the archiblast into two equal sized parts. Both are divided from each other by this furrow, but at their bases or lower surface they are still continuous with the underlying parablast. Each nucleus of the two portions of the archiblast soon begins to prepare for another division, and in the parablast two free nuclei may be observed, which are also getting ready to divide. At the same time the separation of the archiblast from the parablast, at the base of the former, begins to manifest itself, and when the archiblast has been divided into four segments they have become quite free in that they have now separated themselves from the parablast below. They then lie on the protoplasmic layer of the latter, and in this layer four free nuclei may now be noted. The cleavage or segmentation now proceeds regularly. When the nuclei of the archiblast have been transformed into new spindles, the same takes place with the nuclei of the parablast. All of the free nuclei are ever undergoing similar phases of division, or are synchronously in a state of rest, and the nuclei of the segments of the archiblast pass through the same phases, at least during the first few hours of segmentation, whilst at a later period the free nuclei of the parablast pass into a resting stage.

"With the completion of segmentation, the Teleostean egg consists of

a great number of segmentation spheres, comprising the segmented germ-disk or archiblast, and the multinucleated parablast. From the archiblast all of the germinal layers are developed; never does the parablast take part in their formation. That this is the fact is best shown by means of sections, prepared from embryos in much more advanced stages of development, in which the intestine has been developed, and in which we still find these same free nuclei as at first. We may then rightly inquire what is the significance of the protoplasmic covering of the food yelk in which a great multitude of free nuclei are imbedded. The only answer which I can give to this question is the following: The parablast, so rich in free nuclei, assimilates the constituents of the food-yelk, in order to convert them into a form suitable for the growth of the cells of the archiblast, or to convert the yelk into the embryonic layers developed from the archiblast; in other words, the multinucleated parablast assumes the rôle of provisional blood. This view I would justify by the three following sets of facts: (1.) The germ-disk already begins to grow during segmentation. This growth can only take place by the incorporation of nutritive material which can only be supplied by the food-yelk. (2.) During the later stages of development, underneath the embryonic layers, that is, under the embryo itself, one finds the free nuclei heaped upon each other in several layers, and the protoplasmic layer in which they are imbedded very strongly developed, while around the other parts of the yelk they are sparingly developed. (3.) If one places the eggs under conditions injurious to their development, allows them to remain, for example, in stagnant instead of running water, they become abnormally affected. If such eggs are more closely investigated, it is learned that it is the free nuclei which are first affected, in that a fatty degeneration occurs in them, and as soon as abnormal changes occur in the free nuclei, one may be certain that in a short time the germ, or embryo, will be found dead. The free nuclei are also of great importance in nourishing the germ; that is, the embryo.

"What is the fate of the free nuclei, whether they have only a transient existence, or whether the protoplasm in which they are imbedded divides into definite tracts, or, in other words, whether the free nuclei become differentiated into cells at a later period, I do not know, as my investigations have not proceeded so far. If the view should be confirmed which has been taken of them by His—who at any rate erroneously regards these nuclei as originating from leucocytes, which have entered the immature egg—that they become blood corpuscles later, an opinion with which Balfour concurs in regard to their fate in the ova of cartilaginous fishes, would be the strongest evidence in favor of my own view, that they functionate as provisional blood during development. It would then throw light, in a remarkable way, upon the genesis of the blood, as the first blood corpuscle would then be formed at the moment when the egg was divided into the archiblast and parablast or into germ and food-yelk. Kupffer's statement that in just hatched embryos of the her-

ring there was no trace of the presence of blood corpuscles, I can confirm. The same is true of *Crenilabrus*, *Julis*, *Scorpæna*, *Fierasfer*, etc."

In that the yelk hypoblast contains free nuclei in what appears to be a continuous and homogeneous sheet of superficial protoplasm, without any evidence of division into cells or segments, it is truly of the nature of a syncytium as defined by Haeckel, or it may be defined as a multinucleated protoplasmic layer. A. Rauber also speaks of it as a plasmodium, a term borrowed from cryptogamic botany, and first applied to that most remarkable of substances to be met with under rotten wood and damp leaves in moist glens and representing a stage of development of a very singular order of *Fungi*. Plasmodium is as near the ideally structureless non-nucleated condition as one of the *Monera*, but in the case of the germinal layer of the egg of osseous fishes, while it is apparently devoid of nuclear bodies up to the time of the first cleavage, after that it acquires them and really becomes a syncytium, as before stated. The point insisted upon by Hoffman is of great weight in relation to the part it plays in the development of the blood, and in the later stages of embryonic development we shall find that the blood actually develops from it and that the larval blood-vascular system of the yelk is in part actually channeled out of it superficially. This idea was first tacitly formulated by Professor Carl Vogt, now of Geneva, in 1842, when he made use of the term *couche hæmatogéne* in describing the development of *Coregonus palæa*, where it could scarcely escape observation if the lowermost germinal layer in that form shares in the development of the blood as conspicuously as in the embryos of our own whitefish, *Coregonus albus*.

7.—Segmentation of the germinal disk.

When the protoplasmic streams over the surface of the yelk have carried the principal portion of the germinal protoplasm to the disk, these disappear and the cod's egg no longer presents the appearance shown in Fig. 7. When the aggregation of the disk is completed it presents a discoidal, biscuit like form, with the edges blunted or rounded off and thickest in the center. While all evidence of the strands of germinal matter radiating from the edge of the disk has disappeared, a thin veil of germinal protoplasm still remains behind to cover and include the yelk sphere. This stratum in the cod's egg is exceedingly thin and is continuous with the germinal protoplasm of the disk all round the margin of the latter previous to the advent of segmentation. The same condition appears to hold in the case of Salmonoids, Clupeoids, and Cyprinodonts, but in all of these the layer of germinal matter left behind as an envelope for the yelk seems proportionally thicker.

After the germinal disk has been fully developed and has assumed the biscuit form already alluded to, at about the sixth hour, in eggs which hatch in twenty days, it begins to elongate, becoming wider in one direction than in the other, and at the same time more depressed,

with the margins more attenuated than when the formation of the disk was first completed. At the middle of its shortest diameter a transverse furrow now appears, which, by the eighth hour after impregnation, has caused the disk to assume an hour-glass shape when observed from above or below, the two halves being almost exact counterparts of each other. If one will now arrange the mirror of the microscope so as to cause the light to fall upon the eggs obliquely without passing up the tube to the eyepiece, the transparent germinal disk will be found to inclose a very large number of fine granules, which show a disposition to arrange themselves in a definite manner. These granules are found to have aggregated somewhat towards the center of each half of the disk, with a clearer space in the central portion, as shown in Fig. 9, Plate II. The clearer spaces *n* in the opposite halves of the disk may be regarded as the nuclei of the two segments which must have resulted from the first segmentation nucleus included in the germinal disk before it had exhibited any sign of division. The first cleavage may now be regarded as complete, and if the reader will observe the granular bands running across the middle of the disk in Figs. 9 and 10, he will notice clear spaces between them. This is due to an equatorial arrangement of the granules of the germinal matter and indicates the point of separation between the two cells resulting from the first cleavage. The first cleavage of the disk may now be considered complete.

In an hour and a half more, as shown in Fig. 10, the second cleavage has been completed and is indicated by an emargination at either end of the disk and the differentiation of granular bands and a clear space along a furrow traversing the disk at right angles to the segmentation furrow of the first cleavage. The granular bands in both cases being due to the same causes, namely, a polarity which is manifested in the process of cell division in general, from which it results that the granular matter of the protoplasm is arranged in the form of a kind of double partition or plane coinciding with the direction of the cleavage furrow. The cell-plate so defined is represented in Fig. 10, but is not so easy to make out after the segmentation has advanced still farther so as to divide the disk into much smaller segments. We also for the last time have the nuclei distinguished when the disk has been cleft into four segments, afterwards these are not discernible without the use of reagents.

In the course of two to four hours more still further advances have been made in the segmentation or cleavage of the germinal disk, but usually in a very regular way, the segmentation furrows cutting each other at right angles and dividing each of the four cells of the first and second cleavages into at first two and then four masses of nearly equal size. By the twenty-third hour after impregnation, the germinal disk of the cod's egg will have been divided into fourteen to eighteen segments, as shown in Fig. 12 from below and 11 from the side. In Fig. 12 the large cell at the right is just beginning to divide, the incipient

cleavage being merely indicated. When the large cells of the disk commence to divide somewhat later and earlier than each other an irregularity in the form of the cells ensues which tends to restore the circular form of the germinal disk, which after the second and up to and including the third and fourth cleavages had a subquadrate form when seen from above or below. When this stage of development is completed, that is, when the germinal matter of the disk has been split up throughout its entire thickness into a single layer of cells, the morula or mulberry stage of development has been completed.

After the lapse of forty-five hours and a half, or twenty-two and a half hours later, the morula stage has been replaced by another condition of things represented in Fig. 13. Cleavage of the segmentation spheres or cells of the disk also takes place now in a plane parallel to that of the disk itself, so that by this time three layers of cells may be very distinctly made out, which are superimposed upon each other. These layers are the first indication of the development of the germinal layers, and foreshadow the conversion of the germinal disk into a blastoderm in which the epiblast first appears, then the mesoblast and hypoblast. At this stage there is at first, however, no regularity such as might be expected in the disposition of the layers, because the arrangement of the cells is somewhat modified by mutual pressure.

Later still, or on the fourth day, the advance in the cleavage is very marked, the individual cells being only a fraction of the size which they presented on the second day, and they display, moreover, an arrangement into a number of very irregular layers as shown in Fig. 14. Another change has been suffered by the form of the whole disk; it no longer presents the concave inner face shown in Fig. 13, but has become very convex on its inner side and has contracted considerably in transverse diameter and become thicker in the center.

A little way back we hinted that certain irregularities in cleavage manifested themselves at about the time the germinal disk was divided into twelve to sixteen cells or segments. This phenomenon has been noted in the segmentation of an undetermined fish egg by Prof. W. K. Brooks, of Johns Hopkins University. It is also very strikingly developed during the early stages of cleavage in the eggs of the Clupeoids. It would appear that segmentation is a rhythmical process, and that between the phases of actual segmentation there usually, if not always, intervene periods of rest or quiescence. Within the past year I have had very good opportunities upon several occasions to study the transformations of nuclei during the process of segmentation in the early development of the germinal disk and blastoderm of fish ova. These phenomena I have noticed more particularly in hardened and stained preparations, treated with acid carmine, by the use of which the details of the process at various stages may be made palpable. Some of my observations have formed the subject of a short paper published in the Bulletin of the Fish Commission for 1881. That paper, "On the nuclear

cleavage figures developed during the segmentation of the germinal disk of the egg of the salmon," was the result of a study of a comparatively early stage. I have since assured myself by an investigation of the more advanced blastoderms of the ova of the trout and white-fish that complex nuclear metamorphoses continue to manifest themselves much later and are a constant accompaniment of cell division or multiplication in the blastoderm. I have also elsewhere pointed out the effect of fluctuations of temperature in accelerating or retarding the division of nuclei, and consequently its influence upon the rate at which development proceeds. Although these studies are anatomico-physiological in character, their bearing upon the labors of the Fish Commission are important in that they afford us a rational interpretation of a very obscure process, viz, that of growth and development and its dependence upon temperature in cold-blooded vertebrates. If it is agreed that the force which determines development is affected by changes of temperature, it must follow that growth force is in some way dependent upon heat, one of the forms of molecular motion. The facts show that this is true, and that growth,—cell division, appears as if it might be regarded as a form of physiological work exhibited by protoplasm under the direction of determinate laws of nuclear change. It appears that irregularity or asymmetry of development of the cells of the germinal disk is common in meroblastic ova with a large yelk, as is noteworthy in the eggs of birds, reptiles, Elasmobranch and Teleostean fishes, especially during the early stages. This appears to be dependent upon the behavior of the nuclei after the disk has been segmented into several cells. Their metamorphoses from some cause do not exactly keep pace with each other; some divide sooner than others, so that it results that some pairs of incipient cells have already divided before division has begun in others, giving rise to a disk composed of irregular and unequal sized cells at the time when its cleavage into a single layer is completed.

As already stated, the metamorphoses of the nuclei, which have in reality descended from the first segmentation nucleus, are rhythmical. At first round and containing, besides a nucleolus, numerous granules and even granular reticuli, at the time segmentation is about to begin its contents rearrange themselves; the nucleus, in large cells of early stages often showing as a clearer rounded body imbedded in the center of the cellular protoplasm, slowly acquires a more elongate form; at the same time its granular contents tend to arrange themselves in bands nearly at right angles to the plane of cleavage. These lines then seem to undergo a further metamorphosis, in that their substance becomes slowly more homogeneous and is finally aggregated into very refringent rod-like bodies arranged in the form of a wreath or crown at either pole of the nucleus. These wreaths or crowns of refringent rods are then repelled more and more from the plane of cleavage, and at the same time tend to become more densely packed together in a parallel manner.

Their appearance at this time reminds one of an exceedingly minute bundle of cigars, transparent, and now forming the poles of the very elongate nucleus. By this time the equatorial division of the cell into two is practically completed and at right angles to the axis of the controlling center or nuclear body just described. The retrogressive or resting stage now supervenes. The two poles with their bundles of refringent rods are now the nuclear centers of two new cells which have been the result of the cleavage. These two bundles of refringent rods undergo a retrogressive metamorphosis, by which they become globular and take up a larger space in the center of the new cells of which they form a part. The refringent rods disintegrate and the new nuclei, which have passed into the resting or quiescent stage, undergo a repetition of the changes above described during the next stage of segmentation.

The rhythmical phenomena which accompany these internal changes are manifested in the outward changes of form of the protoplasm involved. The cleavage furrows are usually developed with comparative rapidity, accompanied by a tendency to heap up the protoplasm of the two new cells in a conical form. This conical form then gives place to a more depressed one, which coincides with the resting stage. The development of wrinkles in the cleavage furrows, as shown in Figs. 35, 36, 39, and 44, are also to be referred to active movements of the germinal matter, involving more especially the paraplasm or superficial cell substance. In fact these appearances show that contractility of the protoplasm is manifested during development.

Pathological or abnormal phenomena are also manifested during very early stages of the segmentation of the germinal disk. Of such early irregular forms of segmentation, I have represented three in outline in Figs. 36, 37, and 38. The proof that these are abnormal is the fact that the protoplasm of the component cells has become brownish, more distinctly granular and dead. The symmetry seen in Figs. 9, 10, 35, 39, and 44 is wanting. Such appearances are the preludes to the disorganization of the egg, and are as fatal in their results as the appearance known as "rotten spawn" in ova freshly taken from the ovary.

The "rotten spawn," by the way, is interesting as showing that ova may become injured while still within the ovary. Microscopic examination reveals the fact that such ova contain masses of clotted or dead plasma, which is brownish by transmitted light, or whitish like boiled rice by reflected light. This dead or injured protoplasm may involve portions of the yelk only or parts of the outer germinal pellicle as well, and the existence of such a condition in a lot of ova is sufficient to warrant their rejection, for, as a rule, when any eggs from a female fish show this condition, the whole of her spawn is worthless.

To return to the subject proper to this part of our discussion, it is also important to note that the first cleavage furrows do not cut entirely through the germinal disk. The proof of this fact we have in the

existence of a stratum of unsegmented germinal matter lying beneath the disk as a thin layer continuous with that which covers the yelk. This has been noticed by Œllacher, Van Beneden, Rauber, Hoffman, and Van Bambeke, and I have demonstrated the fact to my own satisfaction on the ova of Clupeoids, Salmonoids, and Cyprinodonts. Van Beneden is the only observer who has apparently noted it in what appears to have been the egg of a Gadoid fish. While I have not demonstrated the structure in question in the ovum of the cod, the existence of a primitively structureless yelk membrane is evidence enough of the fact, taken together with what I have demonstrated in the eggs of other species.

The later appearance of free nuclei in the yelk membrane or yelk hypoblast would appear to warrant the inference, which has been shown to be the fact by Hoffmann, that in some way nuclear matter had been left behind in its plasma which had been derived from the first segmentation nucleus, which would account for the germination of blood-cells from its outer surface, as witnessed by Gensch and myself. I am not, at any rate, inclined to believe in the theory of the spontaneous development of nuclei in this layer.

The later phenomena of segmentation of the germinal disk cannot be so well observed in the live egg as the earlier ones, in that the cells become successively smaller and less distinct, until finally the whole disk assumes a lenticular form and is composed of a great multitude of very small cells. Each of these cells, however, when the disk is hardened and stained, reveals the nuclei distinctly, and sometimes one may meet with a cell in the act of division with the nucleus in a condition of metamorphosis. The cells are arranged in very irregular strata, as shown in Fig. 13. This stratification becomes less distinct in Fig. 14, in which the epidermal or epithelial layer is developed as a somewhat thinner stratum than any of the cells below. There is at this period no distinct differentiation of any of the germinal or blastodermic layers, if we except the epithelial differentiation of the outermost layer of the germinal disk.

Beyond this point the differentiation of the germinal disk into the blastoderm, in a portion of which the embryo fish makes its appearance, is very gradual. In fact every step of development is but a prelude to that which is to follow, but of the hidden force or impulse which determines the invariable mode in which it takes place we know very little beyond the fact that it has been named *heredity*. With Whitman we may quote Bergmann and Leuckart: "Jeder einzelne Entwickelungsmoment ist die nothwendige Folge des vorausgegangenen und die Bedingung des folgenden."

8.—Transformation of the germinal disk into the blastoderm.

The next event in the history of the disk is its metamorphosis into the blastoderm, at one side of which the first indications of the embryo make their appearance. This is not fairly accomplished until three

days later than in the stage represented in Fig. 14, or on the seventh day of development. The disk spreads somewhat and becomes decidedly concave on its inner face, at the same time a cavity appears which occupies an eccentric position at one side of and within the blastoderm, as shown in section in Fig. 15. This cavity appears to be the result of further cleavage and is filled with a serous fluid; the cells which inclose it frequently jut into the cavity somewhat irregularly. In Fig. 16, the space occupied by the segmentation cavity is shown by the lighter area *sg* somewhat crescentic in shape and bounded by a thicker rim of cells around its outer margin and the thinner portion of the embryonic disk above. The portion of the blastoderm from which the head of the future embryo will be developed is shown just below *A*, as a rounded promontory of cells projecting into and forming the concave margin of the segmentation cavity. This promontory from *A* to *B* is composed of a number of layers of cells and represents the embryonic disk or shield of authors, in which the first trace of the axis of the body of the embryo becomes apparent. An outline, Fig. 17, more magnified and somewhat older, shows comparatively little change in the form of the blastoderm and segmentation cavity.

The origin of the segmentation cavity as well as the character of its walls has engaged my attention considerably.

Klein * represents it as originating by the elevation of the blastoderm at one side, so that it is freed from contact with the parablast layer lying just below it. In this way a space, filled with fluid, is developed. As far as my own observations enable me to reach a conclusion it appears that the above view of its origin is probably the correct one. The imperfect floor of the cavity is afterwards apparently developed by an ingrowth and budding of scattered cells at its edges and bottom, probably from the yelk membrane (parablast); this floor disappears during a later stage. It is singular that no investigators have recognized the homology of this cavity with the segmentation cavity in the eggs of Elasmobranchs and Amphibia, as pointed out by Balfour, with whose conclusions in this regard I was wholly in accord long before the appearance of the second volume of his monumental work on embryology in 1881. With regard to the details of its development, however, I differ with this authority; and of his statement that it disappears "shortly after the appearance of the medullary plate" I can only say that I have accumulated a very large amount of evidence in proof of the contrary. Inasmuch as the whole of the evidence on this point is now in my possession in the form of sketches from living ova as well as sections, it may be well to give a summary of my views regarding this point with references to previous investigators. H. Rathke is the first to have described the growth of the blastoderm over the yelk and its complete inclosure of the latter as observed by him in 1832 in the development of *Zoarces*.

* Quar. Jour. Mic. Sci., No. LXII, 1876, pp. 113–131, plate VI.

In 1865 Stricker discovered this cavity in the egg of the trout, in consequence of which Œllacher has proposed to name it after him. This cavity is altogether different from what has been described by several authors as appearing in the center of the cellular mass of the disk, and which, as suggested by Œllacher, is, in all probability, a product of reagents. Œllacher also appears to have been aware of the persistence of this cavity up to the time when the yelk blastopore closes. So that so far as I may have any claims to priority in the matter it simply relates to a proof that it persists in a considerable number of genera and is characteristic of the blastoderm of Teleosts in general. Œllacher, however, does not regard it as a segmentation cavity, so that it has remained for Balfour and myself to establish its homology. I at one time believed with Balfour that this cavity was at first closed below by a more or less complete stratum of cells, but if its development is followed to the time when the yelk blastopore is closed it will be found that such is not the case, and that the yelk hypoblast, which is not truly hypoblastic, corresponds simply to the *granular layer* of Balfour. When I say that the yelk envelope, *Dotterhaut*, *couche intermédiaire*, yelk hypoblast, etc., as it has been variously named, is not truly hypoblastic, I mean to imply that no portion of it is in the relation of a hypoblast to the embryo and that it seems to serve simply to inclose the yelk and effect its metamorphosis into blood. The few scattered nuclei in its substance, except just below the embryo's head, cannot be regarded as forming a cellular floor, since in preparations stained with borax carmine these nuclei are seen to be free, much scattered, and simply involved in the plasma of this layer.

It will be seen from the above that my views have undergone some change since the publication of my paper on *Tylosurus;* but these changes of opinion relate entirely to the history and fate of the yelk envelope or intermediary layer of Van Bambeke. I still hold to my interpretation of the homology of the whole amphibian ovum with the disk only of the Teleostean egg; but a discussion of this and other theoretical matters may be more fittingly reserved for the close of this paper.

In other types the segmentation cavity is unquestionably originated as a direct result of cleavage. This is apparently the case in the Teleostean egg; after the blastoderm is fairly formed the germinal mass of cells immediately involved in the development of the embryo, having been detached during segmentation from the germinal matter comprising the yelk envelope, they are freed in great measure from complete contact with the latter except underneath the embryonic disk. Fluid finds access into the cavity beneath the thinner non-embryonic portion of the blastoderm, but as the blastoderm grows the cavity increases in dimensions transversely and diminishes in depth, so that finally a film of fluid of extreme tenuity is interposed between the non-embryonic portion of the blastoderm and the homogeneous yelk membrane. Viewed

in optic section, normal ova sometimes show the segmentation cavity as a space of considerable depth, as is indicated in the outline sketches of sagittal sections of two early stages of the blastoderm of the cod, Figs. 47 and 48. With the further development the depth of the cavity diminishes, often to such an extent as to apparently vanish in ova in which the yelk has been included by the blastoderm. It is to this fact that we may ascribe the belief, current amongst investigators, that it wholly disappears.

It is quite impossible to reconcile the account given by Haeckel with the facts as presented by others, when he implies that the whole under surface of the blastoderm is lifted up from the yelk and remains in contact with the latter only round its margin. The margin at the same time, he says, is reflected inwards, a single layer of cells growing inwards from all sides, to finally close in the center, forming the hypoblast in that manner. This is not in accord with what the writer has seen in the egg, of the cod, nor can it be substantiated by the classical researches of Œllacher made two years prior to Haeckel's,* nor by my own more recent investigations during the past two years. There is no evidence to show that the epiblast of the blastodermic disk is reflected inwards to develop the hypoblast. Haeckel says further, that the clear fluid in the segmentation cavity is resorbed and that the cavity itself disappears entirely. This statement the writer disputes *in toto*, with an abundant support of facts in his behalf. He will only mention here that not only does this cavity persist, but that it also actually increases in size during the later stages of development, as may be observed after yelk absorption has begun, as may be seen in *Coregonus albus*, *Elacate canadus*, *Cybium maculatum*, *Parephippus faber*, etc.

In Fig. 18 the left half of a blastoderm of a cod's egg of the latter part of the seventh day is seen in median section along the plane of the axis of the embryo from A to B; the thickened portion or embryonic area has divided into two thick lamina or strata, each several cells deep. The whole of the upper surface of the blastoderm is covered by a very thin single layer of epiblast cells which pertain to the epithelial layer. The bilaminate condition of the blastoderm extends also into the rim or annulus *r*, which extends around about one-half of the disk and widens just below A, where it is blended and confounded with the embryonic shield or area. The thinner portion of the blastoderm, extending from A to the upper border of *r*, is composed of two layers of cells which roof over the very shallow segmentation cavity. The outer of these is the epithelial layer already referred to, and the inner one composed of rounded cells answers to the sensory layer of embryological writers. Such, in brief, is an outline of the history of the blastoderm immediately after it has clearly become such and before there is as yet any distinct differentiation of the axis of the embryo which is now marked only by the thickest portion of the blastoderm in the median region

* *Jenaische Zeitschrift* IX, 1875.

from A to B. This figure also shows the very narrow slit-like lumen of the segmentation cavity to the right of A, and its extent over the left half of the blastoderm is shown by the line below and to the left of *sg.*

9.—The development of the germinal layers.

This portion of the subject is one upon which I cannot, unfortunately, throw much light on the basis of observations made upon the development of the cod's egg, and I shall therefore place under contribution the labors of Œllacher and others on the trout, and my own observations upon those of several other species. It is evident that in respect to the developmental changes which the blastoderm undergoes in different species, there is considerable variation. In the trout, for example; the embryonic shield or area, corresponding in the cod's egg to the space from A to B in Figs. 16, 17, and 18; there is a considerably less prominent development of the embryonic shield at a correspondingly early stage. In *Tylosurus*, at an early stage, the conditions of the two in respect to the size of the embryonic shield is about the same.

The embryonic shield, as development advances, grows farther and farther inwards towards the center of the blastodermic disk, or rather, as it grows in length before and behind, the disk at the same time spreads in consequence of the continued segmentation of its component cells, so that these are spreading themselves over a greater and greater area while they are at the same time undergoing a definite rearrangement into strata or layers, each of which has a definite share in building up the different parts of the embryo's body. This mode of spreading, however, never affects the relation of the embryo to the edge of the disk. Its tail-end lies at the edge, its head at the center for a considerable time (in small or moderate sized ova constantly), with the axis of the body of the future embryo lying in one of the radii of the disk. In unusually large ova, like those of the salmon, *Tylosurus* and *Arius*, the blastoderm spreads so fast after a while that the embryo does not grow in length rapidly enough to maintain the position of the head near the center of the blastoderm. These last facts explain Œllacher's position in regard to this phenomenon in the trout's ovum.

With the development of the embryonic shield the differentiation of the lower layers commences. The first to be split off is the sensory or epiblastic layer; in the cod's egg this is formed on the seventh day in ova which hatched in sixteen days. The process is truly one of delamination, and cannot be regarded as produced by a true gastrulation at all, as Haeckel has tried to show in a paper already noticed. The process of the differentiation of the layers we saw began with the development of an epithelial layer of epiblast over the surface of the germinal disk before the appearance of the segmentation cavity. Immediately after the appearance of the latter the embryonic disk begins to be developed and the layers differentiated. The sensory layer is split off first from the underlying stratum of cells at the head end of the embry-

onic shield and is continued backwards towards the tail-end of the embryo. This splitting also involves the rim of the blastoderm, which is found to be composed of three strata of cells, viz, the epithelial, the sensory or truly epiblastic, and the lowermost or mesoblastic and hypoblastic. This relation holds throughout the whole disk except at the tail and rim, where the sensory layer and lower one appear to pass over into each other, they appear in fact to be folded upon each other, as shown diagrammatically in Fig. 18 at B and *r*. The two principal layers are at first quite thick; as the disk spreads, however, the portions in the vicinity of the embryonic disk alone maintain their original thickness to a marked extent, and then only along the axis of the embryo as development advances. The two principal strata in the rim *r* also remain thicker, and they are really continuous with those involved in the formation of the embryo. As development of the blastoderm advances, however, its rim becomes narrower and a less marked feature as well as somewhat thinner. The segmentation cavity is roofed over by the epiblast alone, consisting of epithelial and sensory layers only. At first the sensory layer which covers the segmentation cavity is two or more cells deep (*Alosa*), but later this thins out, so that finally when the blastoderm has entirely inclosed the yelk, it is sometimes quite difficult to demonstrate positively that there is more than a single layer of cells present. The layers covering the segmentation cavity in the Salmonoids are thicker than in other species with small ova without a vitelline circulation, and in such forms a mesoblastic stratum may be added to the epiblastic covering of the yelk at a late stage of development. The stratum covering the segmentation cavity in the young codfish just hatched is like that last described. The hypoblast is differentiated later and is confounded or blended with the mesoblast up to the time when the muscular and the peritoneal layers are differentiated, which does not take place till about the time the muscle segments commence to be developed; even after that time it is somewhat difficult to make out the limits of the hypoblastic layer in sections.

The foundations of the embryonic structures of the young fish have been laid down with the development of the epiblastic and mesoblastic tracts of tissue, and the events which follow, especially the development of the brain and spinal cord, which together we will call the neurula hereafter, play a most important part in still further modifying the history of the primary layers. It is somewhat difficult to give a clear account of the development of the neurula without the aid of figures, but this we will now attempt to do as briefly as possible.

10.—Development of the cerebro-spinal axis or neurula.

The development of the brain and nervous system or neurula of the teleostean embryo presents some very remarkable peculiarities, the principal of which is that it is at first quite solid and only develops a neural canal at a relatively late stage, or after the neural cord (*axen-*

strang, His) has been split off distinctly from the epidermal layer overlying it. The formation of the neurula occurs, as will be inferred from what has already been said, in one of the radii of the blastodermic disk. The sensory layer thickens perceptibly along this axis at a very early stage. In the cod's egg this is perceptible on the eighth day of development, as shown in Fig. 19, pl. IV, where the band of cells *P st*, which pass inwards towards the center of the disk of the blastoderm, are the rudiment of neurula or medullary plate from which the nervous system will be differentiated. This rudimentary nervous cord continues to become thicker in a vertical direction as development proceeds, and at last begins to be apparent as a ridge on the under side of the blastoderm. The ventral ridge or keel of the neurula becomes more apparent on the ninth day at the fore part of the embryonic axis, as may be seen in a side view of an egg of that age with its blastoderm in optic section represented in Fig. 20. Another view of an egg of the same age is given in Fig. 21, but here the head end of the embryo is directed toward the observer, and in the darkly shaded portion, which is an optic section of the fore part of the body of the young embryo, shows the neural keel prominently developed on the side next to the yelk. In the embryo of other animals, with two or three exceptions, the development of the neurula takes place in an entirely different manner. In most forms in fact, when the neurula is forming, the epiblast becomes grooved on its external face, while, as the furrow so developed deepens, its sides fold over toward each other to join in the middle line, leaving at the same time a canal throughout the whole length of the neurula and even continued at the hinder end into the primitive intestine or archenteron. Not so with the neurula of the embryos of osseous fishes. Here the neurula is at first an absolutely solid cord or strand of cells which by a slow thickening of the sensory layer at last forms a deep laterally compressed mass of cells which juts down into the yelk, pushing the hypoblast before it. It is even difficult to prove that there is ever any such a thing as a medullary groove or furrow developed at all in the sense in which we know it in the embryos of Amphibians, for example. However, our Fig. 21, pl. IV, shows a depression in the median dorsal line of the embryo at *mg* which we may regard as representing the medullary groove in the blastoderm of the cod of the ninth day. Such a feature is also shown by Œllacher in his figures of sections of the blastoderm of the trout; it is also developed in that of the shad. Calberla in his studies of *Syngnathus* states that the epidermal layer of epithelium is carried down by invagination into the medullary plate along its mesial axis as the neurula is developed. In such sections of similar stages of Clupeoids as I have had the opportunity to study I have seen no evidence of anything of the sort. In this respect they are like the embryos of *Lepidosteus* investigated by Professor Balfour. In this regard Œllacher's investigations upon the trout seem to coincide with the results of Balfour and myself. As

development advances the medullary groove becomes less and less marked in depth, and by the time the embryo's body has been fairly outlined there is nothing more of it visible in sections. For my part I now have serious doubts as to whether any actual infolding of the sensory layer of the blastoderm of Teleosts ever takes place to form the neurula. It would almost seem as if the formation of the medullary plate took place rather by the slow heaping up of the cells of the sensory layer along the neural axis by an amœboid or migratory process. It is at any rate difficult, if not impossible, to find the evidence of any process of infolding of the nervous layer to form the neurula such as has been observed in other types. The mode of development of the neurula, however, as it may be observed in Teleosteans, Amphibians, Elasmobranchs, Marsipobranchs, *Amphioxus*, birds, and mammals, differs so widely in detail and essentials in these different groups as to hinder us from framing any general theory of development for the nervous system of the vertebrates. Such a procedure is all the more to be regarded as premature, in view of the fact that we do not yet know the full history of the development of such forms as *Myxine*, *Lepidosteus*, and *Amia*. What there may still remain to be revealed of a startling or unexpected character, in a study of these forms, we do not know, for the development of none of them is thoroughly known. In fact, the development of comparatively few animals is as thoroughly known for all of their stages as will be demanded by the comparative embryology of the future, so ably heralded by the late Dr. Balfour. The science in its present state may, on account of the imperfection of most of the developmental histories of the principal types, be compared to an ancient manuscript of which just enough has been preserved to give us an idea of the way it treats its subject. Great gaps in our embryological knowledge are apparent in even some of the best studied forms. In one form we know the early history; in another the later. In others we know the development of the germs in the reproductive organs before impregnation; in others we do not. In some cases we know the late phases of development when the embryo or young passes into the adult condition; in others our knowledge in this respect is a blank. Not only is this a serious difficulty, but there is also the still more serious one of reconciling the contradictory statements and observations of honest investigators each of whom has usually added some important information to that which we previously possessed, but who have rarely missed falling into errors of interpretation due to the nature of the subject, defective opportunities and methods; or on account of the finite nature of the mind itself they have been more or less mistaken in making inferences and deductions from the observed facts. This is no discredit to the science, but only a necessary condition through which it must pass in the course of its development.

The blastoderm of the cod's egg, like that of other Teleosts, continues

to spread out and grow over the surface of the yelk sphere underlying it. The blastoderm in fact is molded upon the yelk sphere as a hollow spherical membrane, which finally includes the latter. It grows over the yelk by what is called *epiboly*, the yelk itself remaining passive. The rim *r* of the blastoderm shown in Figs. 20, 21, 22, and 23, Pl. IV, moves progressively toward the naked pole of the yelk, and in its progress more and more of the yelk sphere is covered up. As long as the rim is spreading over the upper pole of the yelk its circumference continues to increase; as soon as it has passed the greatest diameter of the yelk, as shown in Fig. 22, it begins to diminish in circumference. This diminution of the diameter of the rim of the blastoderm continues until it finally closes at the exposed pole of the yelk. At the moment of closure, the free margin of the rim presents a wrinkled appearance, the wrinkles radiating from the center of the small pore which remains up to this time. After the closure of the blastoderm the radial wrinkling disappears. The pore which remains up to within a short time of the closure, is the *yelk blastopore* of authors. The rim which has closed at this point forms a discoidal plate of cells continuous with and forming a part of the tail of the embryo. The cellular disk developed by the closure of the rim may be called the *caudal plate*. It takes a share in the development of the tail of the embryo and also in the muscle plates, neurula, and hind-gut, for the whole of the substance of the rim is appropriated in building up the caudal extremity of the body of the young fish. In Figs. 24 and 25, pl. V, I have represented the appearance of the tail of the embryo cod on the eve of the closure of the blastoderm at the pore *bl*. Other representations of its appearance are given in Figs. 28 *a* and 29 *a*, 29 *b*, and 30 *a* and 30 *b*, the last four being side views. These figures also show, in three instances, the relation of the problematical vesicle *kv* first described by Kupffer, to the blastopore. Their identity is difficult to follow, and I now doubt whether it is anything more than an evanescent structure which has nothing to do with the development of the urinary vesicle or the anal end of the intestine. It is at any rate apparently inconstant in position, and in some fishes evanescent and of temporary importance. Sometimes it appears to be involved in cells, at other times it is clearly surrounded below by the homogeneous yelk membrane or hypoblast alone. In Fig. 26 the blastopore of the yelk is also shown with Kupffer's vesicle lying below the blastoderm as a lenticular vacuole.

As the blastoderm of the cod's egg has spread over the yelk and included it, the neurula has also further developed; the most marked feature of its advancing evolution being the increased ventral prominence of its keel or carina, as shown at *cv* in Fig. 22. At the same time it also becomes more prominent dorsally, as is shown by the same figure, the fore or cephalic end of the body of the embryo is now pronounced in outline, and the principal paired sensory appendages of the neurula become more prominent. The only sensory appendages of the

neurula, which are in direct connection with it from the first, are the optic vesicles or rudiments of the eyes. They are the first of the sensory structures of the young fish to be developed. They, in fact, are already apparent at a very early stage of development, and are formed as lateral outgrowths of the extreme anterior end of the neurula, after the eighth day, and by the ninth day, as shown in Figs. 20 and 21, *op*, they are conspicuous as thickened lateral lobes of the anterior portion of the cephalic end of the rudimentary neural system. Their development in Teleostean embryos is to a certain extent characteristic, in consequence of their great relative size in proportion to other parts of the nervous system at this time. At first their connection with the neurula is quite lateral and anterior; as development proceeds, however, the down growth of the carina or keel of the neurula carries their stalks or points of attachment downward. The place where they arise from the keel marks the position of the origin of the optic nerves, in the vicinity where the cerebrum is continued into the more posterior portions of the brain or thalam-encephalon. During the early stages of their development, they, like the neurula itself, are composed of a solid depressed ovoidal mass of cells. As development proceeds, this mass acquires a lumen or cavity, which is at first a mere cleft like the primitive cerebral lumen or cavity. The cavity of the optic vesicles in section is at first somewhat oblique to the plane of the blastoderm, but this feature is lost with advancing development, and the lower wall of the optic vesicle is finally pushed inward, upward, and more towards the axis of the embryo, while the hind wall itself is also raised so that both together assume a more nearly vertical position. This condition is shown Fig. 27, taken from the head of an embryo eleven days old. The rudiment of the eye-ball is now more nearly vertical and oval as seen from the side. It is now a very depressed double-walled cup as viewed from above, and is connected by a hollow stalk with the lower forward part of the brain. In Fig. 27 its stalk lies just behind and below the rudiment of the nasal or olfactory pit *na*, and its outer lamina *op* is afterwards transformed into the retina, while the inner thinner lamina becomes covered by the choroid or pigmented layer, and the thickened epithelial tract of epiblast *l* is carried inwards with the further development of the eye-ball, and transformed by invagination and further metamorphosis into the lens. The central part of the thickened rudiment *l*, of the lens, becomes the transparent, posterior highly refractive fibrous part, while the surrounding thinner margin of the layer *l* is reflected over the thicker hinder part, as a thin layer of epithelial cells. After this the lens is constricted off from the epithelium and the construction of the eye is essentially completed. The further development, however, of the eye involves the consideration of still other events in the history of its layers. The development of the lens is shown in Figs. 26, 27, 29, and 30. In Fig. 29 the outer epithelial layer is shown, inclosing, as it were, the columnar internal refringent layer within. The optic cup is still open below on

the fourteenth day as shown in Fig. 31. The rim of the cup seems, in fact, to grow down from above and, gradually becoming more globular in form as a whole, its free lower borders approximate and coalesce, forming the choroidal fissure *fc*, through the proximal part of which the optic nerve enters the eye. The inner walls of the choroidal fissure at its hinder part may be regarded as continued into the optic stalk, and it so happens that the optic nerve finally loses all connection with the outer wall of the optic cup and perforates it to connect itself with the inner and thicker layer which has become the retina. The optic stalk itself is, for the most part, if not entirely, converted into the optic nerve and crus. With the further development of the optic cup, its rim is reflected inwards and more fully covers the lens and becomes thinner. After this stage it is said that in other forms the iris, with its muscles, pigment, etc., are derived from the mesoblast around the choroid at the rim of the optic cup. The cornea grows from a ring of cells of uncertain origin just below the epithelial layer of the epiblast at the time the lens is invaginated, according to Balfour. The vitreous humor is developed in much greater proportion at a very early stage in some forms than in others. In *Tylosurus* and *Apeltes* it develops relatively early; in other forms, as *Gadus* for example, it is not perceptible until about the time of hatching. The vitreous humor appears to be gradually developed and seems to me to be a fluid transudation; perhaps it really arises as an ingrowth through the choroidal fissure, as held by Balfour. The aqueous humor develops, according to the last authority, within the ring-like rudiment of the cornea, the cavity of which enlarges as development advances. The brilliant silvery pigment of the iris of the young cod is very probably of mesoblastic origin. Of the development of the muscles of the eye little can be said here, as little is known of the subject. The study of the development of the muscles, by the way, is a department of embryology not yet sufficiently well cultivated. The blood-vessels of the eye enter the organ through the choroid fissure. The eye is already functionally active at a very early stage or upon the eve of hatching, as I have detected movements of the eye-ball even just before the young fish had left the egg. Its complete pigmentation is accomplished by the time the embryo frees itself from the egg-membrane, but most species of fishes do not begin to swim actively for some time afterwards. In others of very rapid development, the movements which are made are not sustained but fitful in character, and often executed with astonishing velocity. That the eye is already functionally active is proved by the ability to instantly recognize an approaching object in the water manifested by young fishes a day or so old. They already see well enough in most cases to try to avoid being caught with a pipette or small skim net.

The account which precedes has dealt in large part with the evolution of the eye of the young fish and has carried us far beyond the time when the neurula has been fully formed. Coincident with the increas-

ing prominence of the ventral keel of the blastoderm, as shown in Fig. 22, another process has been going on by which the tissues of the neurula have been more markedly differentiated from those adjacent. A very distinct line of demarkation is established on either side of the neurula separating it from the muscular mesoblast on either hand; this is shown in Fig. 23. This demarkation was, however, already established when the sensory layer was split off from that lying below it, but as the carina of the neurula is developed, the mesoblast is gradually separated off into two lateral masses, the stratum of hypoblast and mesoblast below the neurula being now only a relatively very thin layer which it has apparently pushed down before it. The line of separation between the sensory and muscular layers at first coincided with the plane of their upper and lower surfaces, but as the neurula grew in depth, this line of separation became more and more nearly vertical at the sides of the latter. In the cod's blastoderm this is accomplished about the tenth day in embryos which hatch in from sixteen to eighteen days, and before the closure of the blastoderm over the yelk. The muscular layer has by this time also been quite separated from the peritoneal layer below it, and the *muscle plates*, as we may designate the three-sided, longitudinal, lateral masses of cells on either side of the neurula, extend from behind the optic vesicles up to the tail end of the embryo and are continued into the lower layer of the rim of the blastoderm at *r*. The substance of this rim seems, in fact, to be entirely incorporated into the building up of the embryo's body, up to the time the blastoderm has inclosed the yelk. The neurula has meanwhile also been undergoing further differentiation. At its front end in the vicinity of *cv*, Fig. 23, a distinct median split or cleft has appeared in it which extends forward and backward some way, but is not developed in the tail end of this structure. This cleft or cavity in the fore part of the neurula represents the neural canal of other types, and from it in the head region the cerebral vesicles will arise at a later period. At the tail end, on the other hand, the neurula is solid, and on the caudal swelling no trace of the medullary groove is visible. The caudal swelling is a mass of cells in which it is impossible to discover any traces of the differentiation of laminæ or layers, except that of the outermost epiblastic or dermal layer. The development of the neurula proceeds therefore from the head towards the tail end of the embryonic axis, where it also grows in length as the rim *r* of the blastoderm advances to finally close over the yelk. Once the closure is accomplished the neurula becomes more defined at the caudal region; it was greatly depressed here on the eve of closure, but the caudal end of the embryo rapidly thickens as it incorporates the caudal plate derived from the rim of the blastoderm. The now more pronounced development of the caudal extremity of the neurula is due to a process very similar to that concerned in the formation of the keel or carina at the head end of the embryo; in fact the keel of the neurula develops from before backwards just as does its lumen or cavity.

The next event in the history of the development of the neurula is its separation from the epithelial layer of the epiblast. This occurs cotemporaneously with the development of its internal lumen, and proceeds from before backwards. The epithelial layer, in fact probably the subjacent layer of the corium itself, has the same history, being developed somewhat sooner in the cephalic than in the caudal region. With this the hitherto flat upper portion of the neurula becomes rounded off except at the tail end. It is now separated from the skin. During this time the skin has commenced to develop pigment in its deeper layer, as shown in Fig. 31. These pigment cells are stellate and exhibit a slow amœboid or migratory movement as development proceeds, becoming aggregated at a later period by this means into patches upon definite regions of the body.

With the further progress of development the tail commences to bud out from the caudal end of the embryonic axis, which at this point continues to become gradually thicker and more prominent and finally swells out into a hemispherical prominence just above the point of closure of the blastoderm. This is the rudiment of the tail of the embryo. In an embryo sixteen days old represented in Fig. 32 the tail has grown out for a considerable distance, and it has been bent over to one side on account of the confined space in the egg-membrane, so that its dorso-ventral axis is turned at nearly right angles to that of the body. A slight fold extends over its end and dorsally and ventrally which is entirely composed of the skin layer. This fold, *nf*, may be regarded as the beginning of the embryonic natatory fold and develops in height from behind forwards as embryonic evolution advances.

With the outgrowth of the tail the development of the neurula is continued backwards and its extreme hinder extremity remains solid as in Fig. 31, and continuous with the same mass of cells from which the chorda dorsalis or notochord *ch* takes its rise. This continuity of the extreme posterior extremity of the notochord with the neurula is maintained until the tail of the embryo is fully developed. Indeed, after hatching even, in the young cod and most other forms studied by the writer, the chorda is lost in a caudal cellular mass and its end is not included within the urostyle until a considerable time after the young fish is free. I have never met with young cod old enough to see the development of the bones of the tail. The muscular layer is also continued backwards into the tail and clasps, on either side, the neurula and chorda. Lastly the skin or dermal layer is also developed in extent in order to keep pace with the tail as the latter lengthens. The whole process of the growth of the tail is a very remarkable one, and in the cod's embryo, for example, it is hard to understand how the material for so much new structure is transported to its new location without the help of a vascular system, no trace of which has yet appeared. The new matter seems to be added by apposition and intussusception. How much of this process may be due to the amœboid properties of the

germinal matter concerned in building up new structures in the way in which we see that the tail is evolved we do not know. And yet it is very hard to see how it is possible for new material to pass through and around the cells and cellular structures already built up, to reach the extremity of the tail in order to add to its length and bulk.

11.—The development of the brain.

The brain or encephalon of the embryo cod, on the fourteenth day, has somewhat the form of a vertical flat rhomboidal sack, its interior bluntly pointed extremity being the rudiment of the cerebrum, and its hinder part is continued into the anterior end of the neurula or neural tube, as the embryonic spinal cord may now be called. On the tenth day it already begins to become thicker behind the posterior borders of the optic vesicles. By the eleventh day a distinct constriction of the cephalic end of the neurula behind the eyes divides the latter into an anterior and posterior portion, as shown in Fig. 27, but it can hardly as yet be said that a cerebral vesicle has developed, for there is now present only a vertical cleft in the center of the cerebral end *cv* of the neurula. The walls of the brain of Teleostean embryos of this stage, unlike those of other types, are now very thick. They consist in fact of two thick flat plates of cells placed vertically between the eyes. The first constriction *tf* of Fig. 27 marks the boundary between the mid-brain and the cerebellum. At a later period a constriction appears a little way behind this one which marks off the cerebellum and medulla oblongata from each other. This occurs about the twelfth day, when the fore part of the brain rudiment also acquires another constriction which separates the mid-brain from the cerebrum or fore-brain as shown in Figs. 29 and 30. By the fourteenth day the cerebral regions have been developed and the first, second, third, and fourth vesicles or cerebral cavities are present, but they still retain the laterally compressed form characteristic of the early stages of Teleostean brain-development.

The so-called ventral bend or flexure of the encephalon in the embryos of other types is almost null in the Teleostean embryo. In fact, I much doubt if it can be shown that any flexure occurs, as the development of the brain of the osseous fish can be accounted for on another principle. With the great development of the ventral keel of the neurula at the head end of the embryo the vertical depth of the encephalon is almost as great as when the cerebral vesicles are developed. If an invagination upwards and forwards of the floor of the brain now takes place, so as to develop the infundibulum in front of it, the construction of the brain of the late stages is attained. My reason for holding that the infundibulum is developed in this way, is the fact that no perceptible downward flexure of the encephalon ever occurs prior to the development of that portion of the brain. Moreover, the infundibulum is developed long before the head becomes free from the yelk-sack, and therefore before a downward flexure of the brain is possible to any

marked extent. Doubtless, the infundibulum is also partially developed as a downgrowth of the floor of the brain, but this need not involve the whole encephalon in a downward flexure. During the earliest stages of the brain development here described, the whole brain region is but little wider than that of the body; with its more advanced development, however, the cephalic end of the embryo widens, in consequence mainly of the rapid growth of the mid-brain in a lateral direction. If a section of an embryo's head is prepared of the age of Fig. 30, cutting through the region of the mid-brain, the mid-brain cavity will be shown as a cruciform opening, the lateral portions passing into the hollow lateral lobes, *mb* Fig. 30, which are pushed out towards the eyes. When, however, sections of much later stages are prepared this arrangement disappears; the optic thalami have acquired greater development; in fact, the whole ventral portion of the mid-brain has augmented in volume, and the origins of the lateral lobes seem to have been elevated while the lobes themselves curve down over the underlying brain substance, abutting laterally against the eyes and behind against the cerebellum. The lateral lobe of the right side of the mid-brain is shown at *ll* in Fig. 28.

Behind the infundibulum, shown in Figs. 28, 29, 30, and 32, the medulla oblongata has a very thick floor, in just hatched embryos, while the roof of the fourth ventricle, contained in it, is quite thin. The thick floor of the medulla in embryos of *Alosa*, three days old, passes straight forwards over the infundibulum to just above the optic thalamus. The bundles of commissural fibers connecting the various parts of the brain, especially those arising from the floor and traversing its substance in various directions, I have not traced. This portion of the medulla is shown in the optic section represented in Fig. 28.

The pineal gland appears as a mesial outgrowth from the anterior portion of the mid-brain, being fairly developed on the eve of hatching or shortly before it, as indicated in Fig. 32, at *pn*, in a side view of an embryo cod on the sixteenth day of incubation. This organ has recently received a good deal of attention on account of the relation it has been supposed to bear to the primitive mouth of the vertebrates. Goette has described it as being a product of the point where the roof of the brain remains longest attached to the external skin in amphibian embryos, and he compares the pineal gland to the long-persisting pore which leads into the neurula of the embryo of *Amphioxus*.

Some days after hatching I have taken the embryos of *Alosa* and prepared longitudinal vertical sections of the head in order to discover what might be the true relation of the hypophysis to the infundibulum. Dohrn * has recently investigated this feature of the development of Teleostean embryos and has arrived at the conclusion that the hypophysis is really formed from the hypoblast and not from an epiblastic

* *Studien zur Urgeschichte des Wirbelthierkörpers. Mitth. aus der zoöl. Station zu Neapel*, III, 1881.

oral invagination, as is the case with birds, mammals, Elasmobranchs, and Amphibians. I have a number of such longitudinal sections of *Alosa* which show the hypophysis connected with the oral ephithelium by a narrow stalk. In sections of much earlier embryos I find it exceedingly difficult to detect this structure with certainty. I believe, however, that Professor Dohrn is quite right in holding to the belief that it does not originate from an epiblastic involution of the stomodæum. In fact it would almost seem to be demonstrated that the mouth of the young fish is developed, as Dohrn shows, from behind forwards and that it really has no stomodæum as we know that structure in other forms. According to the above mentioned authority the mouth is developed from the anterior part of the mesenteron and that it at first grows out as two narrow, pointed, horizontal clefts which break through at two points on either side of the middle line even before the head has grown out over and beyond the epiblast which is continued over the snout and down over the yelk. This is a very singular state of affairs, but I am not assured from my own investigations that what was observed in vertical longitudinal sections of *Hippocampus* and *Belone* will apply to *Alosa.* The origin of the mouth of the Teleostean embryo is a very difficult subject to work out. In embryos in which the mouth is just on the eve of opening I cannot convince myself positively that I can see what Dohrn claims to have done. It is true there seems to be a less pronounced development of the oral tract of hypoblast near the point where the mouth ought to open in the middle line, but I cannot convince myself of its total absence. In sections off of the middle line the walls of the oral opening are more pronounced, but I can not yet agree that it is decided that the mouth of the Teleostean embryo first opens at two points a little way off of the middle line. In living embryos as well as in hardened ones, treated with chromic acid, the mouth opens as a small tranverse opening, and as development proceeds the rim of the upper jaw is carried forward beyond the line of the lower. But this is digressing again from the subject of the hypophysis, which it appears we cannot regard in the present state of our knowledge at least, as certainly originating from an oral invagination. Although the hypophysis is not a part of the brain, as has been positively demonstrated by Rathke, Goette, Balfour, Dohrn, and others, its development naturally falls within the limits of a description of the formation of that organ. It is a very diminutive structure in Teleostean embryos, even after hatching, and is pushed up between the cranial trabeculæ, still retaining its connection with the oral epithelium even on the third day after incubation in *Alosa.* It rests in a bowl-shaped depression on the lower face of the infundibulum and only two or three of a series of thin sections through the mesial region will usually strike it.

The pineal gland, on the other hand, is clearly a part of the brain; sections through the middle line often strike it and show it as a depressed, biscuit-shaped body with a stalk at its anterior portion connecting it with the forepart of the roof of the mid-brain. It is very

difficult to see this part of the brain distinctly in living embryos, on account of their transparency and the consequent impossibility of making out its limits with distinctness, surrounded as it is by structures very similar in optical character.

In a few instances I have succeeded in getting horizontal sections through the plane of the optic crus of embryo fishes. It presents nothing different, at a relatively late stage, from what is seen in the structure of the same part in the adult. The development of the cerebral hemispheres seems to take place relatively late in embryonic life, and they also retain a remarkable solidity. The cerebral hemispheres grow somewhat in size after the larval period of development is past, but in most *Teleostei* they never attain the dimensions of the mid-brain.

12.—The olfactory and auditory organs.

At a comparatively early stage of development the nasal organs are differentiated from a pair of small circular tracts of the sensory layer of the epiblast lying between the anterior extremity of the neurula and the optic vesicles as shown at *na* in Figs. 26 and 27. At a late stage, with the advance of development and the consequent growth and shifting of the parts in relation to each other at the forepart of the head, the nasal involutions or sacks are displaced downwards so that as the head of the embryo grows in thickness and juts forward more, they are carried down nearer to the point where the mouth will open. They thus finally come to lie nearer the margin of the upper jaw than would be supposed possible, judging from their original position. They are at first simple thickenings of the sensory layer; by the fourteenth day in the young cod they have been completely involuted as thick saccular depressions continuous at their borders with the skin. The thick columnar epithelium which clothes them is the olfactory or Schneiderian membrane, which during the later larval or even, in most cases, probably, the post-larval stages become involuted into folds which have a radial arrangement on the floor of the nasal sack, with secondary ridges connecting them. During this time also the nasal membraneous bridge is developed across the pit, in consequence of which it acquires ventral and dorsal openings which communicate with each other. The bridge itself may in some cases be developed as a considerable flap-like external process, or there may be a considerable space intervening between the dorsal and ventral openings of the nasal organ. The other changes which the olfactory organs undergo during the post-larval development of the young fish are principally those of position and changes in the length of the olfactory nerve. This last is at first extremely short. I believe it to originate primarily from the upper hinder portion of the neurula destined to form the cerebrum, from what Marshall and Balfour have called the neural crest; at any rate, there is much to favor this view from what we may learn from an examination of stages such as those represented in Figs. 26 and 27. As development proceeds, its

origin would seem to be carried downwards like that of the optic nerves or stalks as they may at first be called; but of course the olfactory nerve develops later than the optic. In relatively late stages, or after hatching, transverse sections show the roots of the olfactory nerves arising from the sides of the cerebral lobes and passing to the nasal pits. As the snout develops, however, the nasal organs of the young fish assume a more elevated and posterior position, while in some cases, in consequence of the great forward development of the vomer, parasphenoid, ethmoid, premaxillary, prefrontal, and maxillary bones, the nasal organs are carried very far forwards so that the olfactory nerve may require to be prolonged several inches in the adult before it reaches the nasal organ.

The auditory organs, like the nasal, are involutions of the sensory layer of the epiblast. In the cod their rudiments begin to develop on about the tenth day; by the twelfth, at first apparently solid, their involution has been completed, and they are present on the fourteenth as a pair of very thick-walled ovoidal vesicles, with a very small cavity, as shown in Fig. 26, *au*. This internal cavity gradually increases in size, while the walls themselves become gradually thinner. The contents of the vesicle is apparently a fluid lymph; on the fifteenth day two very refringent bodies make their appearance in the auditory vesicle on its internal wall; these are the otoliths, the *asterisk* and *sagitta*, as they are named, respectively. With the development of the auditory vesicle they increase somewhat in size; they are calcareous in composition and have a depressed spheroidal form, with a radiate fibrous structure. The exact mode of development of the otoliths is not well known. With the progress of development the auditory vesicles elongate somewhat antero-posteriorly, the inner portion becomes vestibular in character, and the otoliths lie against its inner wall, near the ventral border of the sack. At the time of its involution it would appear that the auditory nerve or its rudiment was developed from the side of the hind brain. Sections of the later stages through the auditory vesicles show the roots of the auditory nerves arising from the side of the medulla, pretty high up, and curving down on the inner face to the lower anterior part of the inner side of the auditory vesicle. They enter the vesicle on its lower inner side, and terminate in a cushion of columnar epithelial cells, which are surmounted by fine, hair-like protoplasmic filaments, which project freely into the endolymph of the utriculus, as we may call that portion of the auditory vesicle at this stage of its development. The sensory terminal cushion, in which the auditory nerve ends, is evidently an acoustic macula; in its vicinity pigment cells are usually developed in considerable numbers some time after incubation. The horizontal anterior and posterior semicircular canals are apparently developed by the infolding of the walls of the auditory vesicle. These folds first appear as ridges, which apparently grow inwards in such a way as to shut off the semicircular canals from the vesicle, except at

their ends. Beyond this stage I have not followed them, and it only remains to suggest that the canals are further developed by growth in length, in the course of which the curved tubular portions are elevated and separated from the utriculus. As regards the sacculus, I have no observations of value to record; this structure, as far as I can make out, seems to be developed during the post-larval period. The connection of the auditory vesicle with the air-bladder seems also to take place at a late period, for in all the forms observed by me the diverticulum of the fore-gut, which gives rise to it, is quite rudimentary, even up to the time when the semicircular canals of the ear have been formed. It only remains for us to call attention here to the fact that both the auditory and olfactory organs are less intimately connected with the evolution of the neurula or larval nervous system than the eyes, which are connected with it from the first moment of their development, seeming, in fact, to be mere outgrowths of that system. The internal ears and the nasal organs, on the other hand, are formed as paired involutions of the epiblast, their connection with the nervous system being established in a manner entirely different from that of the eyes.

13.—THE LATERAL SENSORY ORGANS OF THE LARVAL COD.

These organs have a rather singular distribution in the young codfish just hatched. There are five of them to be seen on either side of the body, as may be noticed in Figs. 40 and 42, but on the head and on the side of the body they are not placed on the middle of the side, as they are on the tail. About three of them are placed on either side of the tail, as may be seen in Fig. 42, at *sh*. A nerve filament, *nf*, Fig. 43, passes out to each of them, and is presumably connected with the nervous system, but the exact relations of these nervous connections I have failed to make out. The nerve fiber which passes out to the one on the head, Fig. 40, *sh*, appears to arise from the medulla oblongata; in the one behind the pectoral fin, on the side of the body, at the base of the dorsal natatory fold, the nerve going to it seems to arise from the spinal cord. In both cases faint filamentous prolongations from these two nerve eminences are seen to be prolonged anteriorly and posteriorly in the skin. These filaments, I take it, represent the nerve of the lateral line, evidence of the presence of which is seen in the serial arrangement of the sensory eminences, *sh*, themselves. They are not nearly as numerous as the muscular segments, a feature in which the larval cod differs greatly from the larva of *Gambusia patruelis* where these sensory elevations correspond exactly to the number of muscular segments. This segmental arrangement of the sensory eminences or nerve hills has also been noticed in other larval fishes by Schulze, and is an exceedingly interesting fact. In a good many other forms of larvæ of osseous fishes these lateral sensory eminences are not developed at all at the time of hatching. This is the case with *Alosa* and *Pomolobus*. We have therefore all grades of their development in known types, from none to a few

in *Gadus*, on to that in which every muscular segment has its corresponding pair of nerve hills or eminences. Their function is evidently a sensory one, and their serial relation to the auditory, optic, and olfactory organs is at least suggestive, if nothing more. The structure of these hills, however, bears a most remarkable resemblance to the ending of the auditory nerve in the auditory vesicle, even as regards details.

They appear to be mere local lenticular thickenings of the skin, connected by a nerve filament with the spinal nervous axis, and with careful illumination one may see that these bodies are surmounted externally by very fine, hyaline protoplasmic filaments, which extend freely into the surrounding water, but which are perfectly rigid and immobile. In this they exactly resemble the similar filaments which are met with surmounting the macula or cushion-shaped termination of the auditory nerve. There is much room here, for one disposed to speculate, to suggest a probable explanation of such remarkable resemblances. Dercum has suggested that they may possibly serve to appreciate vibrations not perceptible to the ear, serving perhaps to enable the animal to detect the approach of another body, which starts the surrounding fluid medium into slow vibration. Their columnar epithelial structure has been determined by observers, but the nature of the process by which they become converted into the covered system of the lateral line, as found in the adult, still remains to be worked out. In the adult, one or more rows of scales are often involved in the structure of the canals of the lateral line system, these scales having a tube developed along their longitudinal axis, or it may even be branched. Within these tubes, which also open in various ways to communicate with the outside, a complex system of nerve buttons or eminences are found, which are evidently akin to the nerve hills found in the larvæ as naked dermal elevations. Some of the mounted preparations of these structures of the adult, treated with osmic acid and hæmatoxylon, prepared by Dr. Dercum, have a remarkable likeness in some respects to the ending of the eighth nerve in the auditory vesicle of larval fishes.

Balfour found the lateral line system of Elasmobranchs to be innervated from the ninth pair or vagus nerve. Such a relation of the first nerve hill on the head of the young cod is conceivable, but I am assured that nervous fibers pass inwards separately to the nervous axis from each of the others behind it, so that such a relation to the vagus is here scarcely possible for the latter. The inclosure of the lateral line system is probably accomplished by the development of folds of the skin above and below the series of nerve hills, these folds coalescing finally to form a canal open to the exterior at intervals.

The single median barbel on the lower jaw of the adult cod is also a sensory organ of a special kind, but is not developed until the young are older than the oldest figured in the plates accompanying this memoir. It is therefore developed during the post-larval stages. Leydig has in-

vestigated these structures in other forms microscopically, and shown them to contain sensory end-organs of a highly specialized character.

Besides the foregoing nervous dermal structures, there are present upon the skin of the larvæ of some forms a very singular type of structures which have apparently not been much studied. These are the goblet cells of the skin. Their function is probably not sensory, but secretory, pouring out a mucous substance over the skin. In the early stages of young fishes generally which I have studied they are usually absent; in fact, I have never met with them except in the larvæ of those Salmonoids with large ova and embryos. They are apparently unicellular, (Gegenbaur); at least this is their appearance in the young of *Salmo* and *Oncorhynchus*. In form they are globular, with a wide, trumpet-shaped mouth or external extremity, which apparently represents the efferent opening of these unicellular glands. They are very numerous, imbedded in the epithelium of salmon embryos, and are found all over the head and body, extending even over the whole of the yelk-sack, which is thickly studded with them.

14.—Development of the notochord.

The disputed question of the particular layer from which this organ in the Teleostean embryo is derived I am unable to settle definitely. Some authorities hold that it is derived from the ventral edge of the neural keel by delamination, being split off from before backwards as a chord of cells. It is not certain, however, that it may not originate from the lower layer or hypoblast, and not from the neural keel; at any rate, a more exhaustive study of the subject is still required before a definite conclusion can be reached in regard to the origin of this organ. It is developed before the intestine acquires a lumen, and while that structure is still a solid median band of hypoblast cells, lying just below the primitive chorda. Transverse sections show it as a distinct, slightly depressed rod or cylinder, which extends from just behind the infundibulum, below the medulla oblongata, to the caudal plate or mass of cells, in which its posterior extremity is completely lost. The cells of which it is at first composed are not distinguishable from those of the mesoblastic muscular and splanchnic layers on either side of it, but by the time of the closure of the blastoderm over the yelk its presence may be very easily detected in the living embryos as well as in transverse and longitudinal sections of the same, having been distinctly segmented off from the adjacent structures in the vicinity. With the downgrowth of the neurula to form the carina, the mesoblastic tract or layer has undergone changes of development, or rather localization, on either side of the middle line, by which the muscular layer becomes completely separated into two lateral longitudinal masses, with the chorda lying between them, and with only a very thin stratum of splanchnic mesoblast underlying, from which it would appear that the aortic and venous trunks of the body and the peritoneum arise at a later period. This splanchnic layer is in

fact, at this period, almost if not quite continuous with the hypoblast below; at any rate, it is not fairly differentiated as a separate layer until after the chorda has been clearly defined. Up to this time the muscular mesoblast is quite solid and composed of closely packed equal-sized cells. After this stage has been reached the chorda cells themselves commence to enlarge, and the whole chorda acquires a gradual augmentation of volume, affecting most conspicuously its diameter. It also loses its depressed oval form as seen in section and becomes cylindrical. With the increase in diameter, the chorda cells also undergo other changes of shape, in the course of which they become columnar, with their longest axes arranged transversely to the axis of the chorda itself. They are finally so disposed that in longitudinal sections the chorda cells appear as if they were arranged into a series of disks placed transversely within the chorda sheath, which has by this time appeared, or at the stage of development shown in Fig. 31. The changes which now follow are very singular indeed; between or within these discoidal masses of chorda cells cavities appear filled with fluid. These cavities, like the disks or cellular septa, are also placed transversely to the axis of the notochord, and are at first lenticular in form, but by degrees they enlarge and displace the chorda cells, as if they were being pushed to the notochordal wall or sheath. The protoplasmic basis of the notochord gradually disappears from the axis of the organ, until it is wholly replaced by the fluid cavities, which have increased enormously in volume. The walls of the cavities which make up the axial part of the chorda are exceedingly thin, and in just-hatched embryos of several genera I have as yet failed to discover any trace of nuclei in those portions of their walls which extend into the body of the chorda. The walls of the cavities must have been derived from the protoplasm of the cells of the primitive chorda, and their nuclei have probably been transported to the walls of the chorda sheath, where they seem to be very much flattened and spread out upon the inner surface of the outer walls of the great vesicular cells composing the chorda. Lieberkühn* compared the great vesicular cells of the chorda filled with fluid to the vegetable cell with its parietal layer of protoplasm contained in a cellulose wall, the whole inclosing a large sap cavity. This comparison would seem to be fully borne out by the foregoing description of what may be witnessed in the development of the notochord of osseous fishes. The probability—in truth, the fact—must be this: The lenticular vacuoles which we find to originate within the chorda at an early stage are not developed interstitially between the disk-like tracts of primitive chorda cells, but in the cell substance itself. As the vacuoles enlarge they become covered by a layer of plasma, which becomes gradually thinner as the vacuole enlarges. The fluid contents which are found in chorda cells have been accumulated by a process of transudation from the surrounding tissues. As the vacuolated

* *Ueber Bewegungserscheinungen der Zellen. Schr. d. Gesellsch. z. Beford. d gesammt. Naturwissensch. z. Marburg.* Vol. IX, p. 337, 1870.

chorda cells enlarge they lose their lenticular form and gradually become polyhedral, and but two to three of them are found side by side in any one diameter of the chorda. As the growth of the tail of the embryo proceeds, the chorda not only increases in diameter, but it also lengthens, together with the other parts of the caudal extremity, and the metamorphosis from the solid condition to the vacuolated one proceeds from before backwards to the slightly swollen caudal end of the chorda, where it is still in connection with a caudal mass of undifferentiated cells, even after great advances in its development have been made at its anterior end, as shown in Fig. 34. The sheath of the chorda also becomes thinner as development advances, and in *Alosa*, for example, the sheath seems to be formed mainly of the walls of the vacuolated cells which come to the surface. This view of the fate of the walls of the chorda cells lying next the surface of the notochord, with their parietal nuclei, seems also to be in accord with those of Gegenbaur and Balfour. The contents of the vacuolated cells of the notochord in the embryos of osseous fishes are not gelatinous, but quite fluid, and may for the most part be abstracted by alcohol or glycerine, causing the chorda to collapse more or less notably.

The volume of the chorda as observed in the embryos of different genera of the same relative age is subject to a very marked variation. In proportion to the bulk of the remainder of the embryo it is most voluminous in the just hatched young of *Alosa* and *Pomolobus*. In other families I have never met with it in anything like the same proportionate size as compared with the other parts of the body. In cross-section in the Clupeoids it will measure quite three times as much proportionally in area as in *Gambusia*, *Cybium*, *Tylosurus*, *Gadus*, *Parephippus*, *Salmo*, *Idus*, *Esox*, *Morone*, and *Hippocampus*. In the last-mentioned genus no caudal fin is developed, and hence its terminal end undergoes no upward flexure, as is the case with many other forms of Ganoids, Teleosts, and Elasmóbranchs. In *Siphostoma* also there is apparently no alteration in the direction of its caudal end, for here the five or six caudal-fin radii are formed homocercally in the tail fold without affecting the direction of the notochord. The tail of *Hippocampus* is prehensile, however, before the differentiation of the vertebral bodies, and while its skeletal axis is still entirely notochordal.

It would appear that in some forms, at least as development advances, the vacuolated cells of the notochord divide and become smaller. This is apparently the case with *Gambusia patruelis*, in which we may also note a general acceleration in the development of the notochord, by which it presents a tendency to form the external skeletogenous layer and become constricted at points corresponding to the muscle segments, to form the vertebral bodies, even before the yelk-sack is absorbed. In the embryos of this species we also find the cartilaginous sheath very thick at period, and the constrictions, which are visible as the first indications

of the commencing development of the vertebral bodies, have a shape somewhat like an hour-glass with a wide neck, the narrow portion representing the middle of the future vertebral centrum. In *Alosa* of the same relative age as *Gambusia* the sheath of the notochord is exceedingly thin, and cannot be made out even in sections as anything more than the merest film. In *Salmo*, on the other hand, the notochordal sheath, at the time of hatching, is a thick homogeneous membrane several times the thickness of that found in embryos of *Alosa* of the same age, and thicker even than that of *Gambusia*. It follows from what we have learned, from the foregoing comparisons, that we are not warranted in proposing any general theory of the development of the notochordal sheath, even within the limits of a group as restricted as that of *Teleostei*. Of the development of the *membrana elastica externa*, which covers the notochordal sheath, I have nothing to say, not yet having been able to convince myself of its presence in *Alosa*, for instance.

It has been insisted that *Teleostei* "may fairly be described as passing through an Elasmobranch stage, or a stage like that of most pre-jurassic Ganoids, or the sturgeon, as far as concerns their caudal fin" (Balfour, Comp. Embryol., II, 64). We have already noted two exceptions to this rule in the singularly modified pipe-fishes and *Hippocampus*. It now remains to call attention to another type in *Gambusia*, where the extreme tip of the notochord is bent upwards to only the slightest degree; so slightly, indeed, that its extremity is not raised above the level of the dorsal line of the notochord, although the hypural, the urostylar cartilages, and the rudiments of the neural and haemal arches are developed. This is in a comparatively late stage, but when we come to study still earlier stages we do not even find any evidence of the dorsal prominence the same as at the margin of the tail fin of embryos of *Salmo*, which is clearly the margin of the embryonic caudal fin, where the tip of the notochord grows backwards and obliquely upwards into this rudimental structure. Balfour is also in error when he says that in *Salmo* the rays of the caudal fin appear simultaneously above and below the end of the notochord. This is actually the case, however, in *Gambusia*, where at least three fin rays arise even above the end of the still cartilaginous urostyle, while six develop above the level of the notochord itself. This subject has been most fully discussed by A. Agassiz, to whose invaluable memoirs on the development of the caudal fin embryologists will in future be obliged to refer for data.

The anterior flexure of the notochord also varies considerably in different forms. In *Alosa* it is slight after hatching, but in *Hippocampus* it is excessive, and is accounted for by the extensive downward flexure of the head in the region of the neck of this singularly modified Teleost.

The subnotochordal rod is developed as a strand of cells in *Alosa* and *Salmo*, just below the notochord. Œllacher calls it the *aorten-strang*, by which he seems to imply that it shares in the development of the aorta.

15.—Development of the ribs.

The frame-work of the trunk in *Teleostei* varies greatly in character; the heads of the ribs also vary in different forms in relation to their positions with respect to the vertebral axis and the notochord itself, and it is on this account that it will not be possible to frame a general theory of their development from the study of any one form. In some the heads of the ribs articulate with the hæmal processes; in others some distance below the vertebral axis, or directly with the sides of the latter. All that I propose to do at present is to record what I have observed in relation to their development in a single type not hitherto the subject of embryological investigation. In this case the relation of these skeletal appendages to the notochordal axis was so intimate that their discussion may appropriately follow that of the notochord itself.

The form in question in which I have observed some of their stages of development is *Gambusia patruelis* of Baird and Girard, which, as already remarked, tends to develop its skeletal frame-work very precociously as cartilage, even long before the complete absorption of the yelk-sack, which is an unusual feature, and one to be accounted for probably by the fact that this species, like Cyprinodonts generally, develops its young within the ovary viviparously to a remarkable degree of advancement. The embryos used were in an advanced state of gestation in the ovarian follicles, from which they were removed and cut into transverse and longitudinal vertical sections.

In this genus the cartilaginous rudiments of the ribs were found to abut directly against the notochord at its side and above the middle of the side, where the head was somewhat larger in circumference than the distal portions. At the hinder portions of the body cavity their origins were somewhat more ventral than in the middle and anterior regions. They arise in pairs and extend obliquely outward, backwards, and downwards between the muscular and splanchnopleural layers, following the intermuscular septa as perfectly cylindrical rods, and appear to be surrounded by a stratum of connective tissue, which is continuous with that surrounding the notochord, and in which presumably the ossification of the vertebral bodies and the first superficial sheath of bone of the ribs themselves will take place at a later period. From their origin at the sides of the notochord, in the middle region of the body, they bend downwards and follow the courses of the septa between the muscular plates, just where these terminate on the splanchnopleure. The foregoing describes fairly their relations to the surrounding tissues, but their finer structure is somewhat remarkable and calls for special notice. They do not present the appearance of cartilage as seen in the cartilaginous rods of the branchial arches of the same embryo, nor that of the parachordal plates or trabecular cartilage of the base of the skull. They, in fact, recall nothing of the structure of any

other part of the embryonic skeletal frame-work of any form with which I am acquainted. Perfectly cylindrical rods from their origins at the sides of the notochord, they consist of a single row of hollow, discoidal, apparently vacuolated cells, apposed by their flat surfaces. In their vacuolated condition their component cells resemble the notochord, of which they are evidently appendages, as already stated. The question now arises, do they originate from a single line of solid cells along the intermuscular septa? Their condition as observed by us would appear to favor such a view. The question is also raised as to their appendicular relation to the notochord; and what is the significance of their direct connection with the sides of the chorda? They appear like miniature lateral repetitions of the chorda, but, unlike it, to be formed of but a single linear row of vacuolated cells. Their points of insertion I have not certainly determined to be intervertebral, but such they probably are, since their courses follow the muscular septa. Hoffman has urged a similar relation of the ribs and chorda in the embryos of other forms, but I have not seen his paper on the subject. At these stages of development of *Gambusia* the muscular plates were far advanced in development and already presented the condition of a congeries of fibrillated, cylindrical, or oval bundles of muscle fibers, and the distinction into dorso-lateral and ventro-lateral masses, with the horizontal lateral septa of connective tissue developed between them.

No observations on the development of the ribs of the young cod were made, for the reason that no embryos of a sufficiently advanced state of growth could be obtained.

16.—Development of the skull.

Upon this subject little can be said here, since, on account of the very minute size of the embryo cod, I have not yet subjected the head of the larva to a thorough examination by means of sections, the only practicable method of studying this part of the skeleton of such a form. Dissection is out of the question. Stated in general terms, my investigation has been conducted as follows: By carefully compressing the embryos under a compressor of the proper form, the cartilaginous basis of the chondrocranium may be revealed if a dilute solution of acetic acid is used to develop the cell contours. I have also found that the chondrocranium of larger forms of osseous fish larvæ could be isolated with tolerable success with the use of a weak solution of caustic potash, which destroys the other soft parts, but does not so readily attack the structure of the embryonic cartilage.

As a result of such modes of investigation, it may, I believe, be stated as generally true that the basicranial plate, perforated by the pituitary space and ensheathing the anterior end of the notochord, is the first portion of the true skeleton to be developed in osseous fishes, but the skeletal axes of the branchial and hyomandibular arches develop their rudiments about the same time. The branchial arches are formed from

the mesoblast of the inner medullary portion of the fleshy branchial arches; the branchial blood vessels are formed in the outer and hinder part of the same medullary tract, which is continuous above with the same layer of tissue from which the cartilaginous basis of the cranium is developed. The remarkable researches of Prof. W. K. Parker upon the development of the skull of the salmon leave nothing to be desired upon that group, but I am assured that many details of the process still remain to be worked out for other forms. For instance, the palato-pterygoid bar does not seem to develop relatively so early in other forms (*Alosa*) as we find in the salmon. Nor is the rostral portion of the basis of the skull nearly so precociously developed; the supraorbital bar is also weaker and arises at a comparatively later stage in *Alosa*. In fact this tendency to manifest a later development of the skull in these types appears to be related to the general backwardness of the condition of development of the median and paired fins. In *Alosa*, for example, there is no sign of cartilaginous fin rays at the time of hatching, while in *Gadus* they are even later in making their appearance. In the salmon, on the other hand, evidences of rudiments of fin rays have already made their appearance at this stage in the tail, in the dorsal, anal, and pectoral fins, while the rudiments of the ventral fins are prominently developed while there is still no sign of them in the embryos of *Gadus* and *Alosa* of the same stage. In *Gambusia* again, in conformity with the generally accelerated condition of the development of the skeleton of the embryo, the skull shows a like tendency to be more fully formed at an early period. In it the cranial tegmen, labial cartilages, the intermaxillary rudiment, supraorbital bars, branchial and hyoidean apparatus have reached a stage much more fully differentiated than in other forms of the same relative age. In the embryos of *Alosa*, for example, at the time of hatching, the basihyal and glossohyal cartilages are still in the form of an unsegmented plate, while in *Gambusia* they have been developed long before incubation is complete. The Meckelian cartilages of the lower jaw, however, develop concurrently with the oral opening and grow in length as its gape increases. The quadrate cartilage retains its solid junction with the metapterygoid in the slow-developing forms above alluded to, just as in the salmon. Conscious of having added but little that is new to this part of the developmental history of osseous fishes, we leave this portion of the subject for fuller treatment at some future time.

17.—THE DEVELOPMENT OF THE UNPAIRED OR MEDIAN FINS.

The development of the unpaired fins from a median dorsal and ventral natatory fold seems to be general amongst osseous fishes, with only a few unimportant exceptions, mainly amongst Lophobranchs. In the cod embryo the natatory fold here alluded to appears soon after the tail buds out from the caudal plate. It is at first a low fold of the skin, as at *nf*, Fig. 32, which extends over the end of the tail and forward on

the dorsal and ventral median line. With the progress of development it becomes more conspicuous, growing in height, so as to soon be very much wider, as may be seen in Fig. 34. Its first appearance is heralded by a faint doubling of the skin upon itself, so as to project outwards as a median ridge, extending from the point of origin of the tail at its ventral margin from the yelk-sack back over the caudal extremity and progressively forward over the median dorsal line towards the head. By the time the embryo leaves the egg this fold extends forward on the back as far as the pineal gland, or to a point just behind the forebrain, as may be seen in Fig. 40. Its development, however, is continued even somewhat farther forward fourteen days after hatching, as shown in Fig. 45, until it ends almost immediately between the nasal pits. At this time its extreme anterior extent gives to the young cod a very singular appearance as viewed from the side, such as is not met within any other form which I have studied. In outline, as viewed from the side, the young fish now bears a resemblance to the conventional representations of the dolphin in old sculptures.

The natatory fold is now actually wider than the caudal portion of the trunk, but it is quite thin and comprises only the skin folded upon itself, its whole thickness being mainly, if not entirely, derived from the epiblast. At first, in all forms known to me, the caudal portion of the natatory fold is rounded in outline, as seen from the side, but may assume a fan-shape, even before a single caudal fin-ray has been developed in it, as is the case in *Alosa* and *Pomolobus*. In others, again, the rays begin to develop before the caudal portion of the primitive median natatory fold has become fan-shaped, as may be seen in *Salmo* and *Oncorhynchus*. In still others there is no continuous median fin-fold developed at all, as in *Gambusia*, *Siphostoma*, and *Hippocampus*, and the median fins grow out at first as short, local, dermal folds, in which fin-rays soon afterwards develop. In those forms in which the unpaired fins are developed from a continuous median fold, the dorsals, anal, and caudal are evolved only in certain regions of the fold itself, the portions of the latter, which do not become fin rudiments, atrophy. Balfour says (Comp. Embryol. II, 63) that "the dorsal and anal fins are developed from this fold by local hypertrophy." The process, however, when narrowly studied, presents features the significance of which cannot be fully apprehended under the term hypertrophy. As stated at the outset, the median larval fin-fold is at first a mere outward duplication of the skin containing no mesoblastic tissue between its laminæ, but as soon as the positions of the fin-rudiments are defined we may note that there has been an outgrowth of mesoblastic tissue into these regions, causing them to become thicker and less transparent. With the progress of this process, the mesoblastic tissue gradually advances toward the margin of the fold, insinuating itself between the epiblastic walls of the continuous fin of the larva. Soon afterwards it becomes evident that the fin-rays are becoming differentiated by the mesoblastic tissue

arranging itself in parallel bands from which the cartilaginous matrix of the rays is developed. The rudiments of the bony sheaths of the rays of the caudal fin in sections of that portion of larval salmon are found to lie almost in contact with the skin and to be crescentic in section. These are evidently the lateral pieces which develop into the bony segmented sheaths of the rays of the adult, which are of much the same form except that they more completely ensheath the cartilaginous matrix of the rays than in the larvæ. At the base of the caudal fin of the salmon embryo the sheaths of the fin-rays lie deeper than in its distal portion, and a stratum of tissue is interposed between the skin and the sheaths of the rays, which is afterwards apparently developed into the flexor muscles of this fin. The cartilages, which afterwards ossify and become the hypural bones, are mesial in position and a considerable thickness of tissue is interposed between them and the rudiments of the rays lying on either side. Such, in general terms, appears to be the process of caudal and median fin development in osseous fishes. In some forms there is a tendency manifested to develop more or less mesoblast in the median fin-fold, and vascular loops also appear in its mesial substance at an early stage of development, as may be seen in the embryos of *Apeltes* and *Tylosurus*. In other forms, again, the median fin-fold retains its thin, transparent, dermal, non-vascular character for a long time after hatching; this is noteworthy in *Alosa*, *Pomolobus*, *Cybium*, *Parephippus*, and *Idus*, while in *Apeltes* vascular loops are present in it by the time of hatching. In *Siphostoma* and *Gambusia* the fin-folds of the unpaired fins grow out as local dermal folds into which mesoblastic tissue is almost immediately insinuated to develop the rays.

It will be evident, from what has preceded, that the theory of the origin of the unpaired fins from continuous folds does not hold in Teleosts; that there are exceptions to it where we should least expect to find them; in fine, that the form of the caudal fin is sometimes outlined before the rays appear or the reverse. It is worth while, however, to point out that in those forms with two or three dorsals (*Gadus*), or where there is a series of dorsal and ventral finlets in the adult (*Cybium*), the continuous larval fin is most apt to be developed, while in those forms where there is a reduction (degeneration) of the fin system, as in the Lophobranchs and *Gambusia* (with but one dorsal), the continuous median fin-fold is not always developed. The last qualification does not hold, however, in all cases, for in the larva of some Cyprinoids, *Idus* and *Carassius* (one dorsal in the adult), I find the continuous fin-fold developed to the same extent as in *Apeltes;* and amongst the Clupeoids, which have but one short dorsal in the adult, it is surprising to find the natatory fold extensively developed. The query arises, why should *Gambusia* form such an anomalous exception? We can understand the cause of the peculiar development of the median fins of Lophobranchs as resulting from their extreme specialization, but in the first case the explanation is not so clear.

The mesoblast, from which the median system of fin rays of the larvæ of osseous fishes is developed, appears to be an outgrowth from between the mesial, dorsal, and ventral points of meeting of the muscle plates, and that it is pushed out into the natatory fold during the development of the skeletal and muscular elements of these fins, and that it is continuous dorsad of the spinal chord, and ventrad of the notochord, with the tract of tissue, from which the interspinous elements of the skeleton are differentiated. It is, therefore, a part of that mesoblastic tract from which the haemal and neural arches, interposed between the dorso-lateral and ventro-lateral plates of muscle-segments, are differentiated, and was primitively continuous with it.

18.—The development of the paired fins.

The paired fins of *Teleostei*, like the limbs of the higher vertebrata, arise locally, not as blunt processes, however, but as short longitudinal folds, with perhaps a few exceptions. The pectorals of *Lepidosteus* originate in the same way. Of the paired fins, the pectoral or anterior pair seems to be the first to be developed; the ventral or pelvic pair often not making their appearance until after the absorption of the yelk-sack has been completed, in other cases before that event, as in *Salmo* and *Gambusia*. The ventral undergoes less alteration of position during its evolution than the pectoral pair.

In that the development of the pectoral or breast fins of *Gadus* is typical of the group we can do no better than describe their evolution in that form, as observed prior to and after hatching. The date of appearance of the first sign of the pectoral fin-fold varies somewhat in different genera, but in *Gadus* it appears as a slight longitudinal elevation of the skin on either side of the body of the embryo a little way behind the auditory vesicles, as shown in Figs. 30, 32, 33, and 34, at *ff*, and shortly after the tail of the embryo begins to bud out. At the very first it appears to be merely a dermal fold, and, in some forms, a layer of cells extends out underneath it from the sides of the body, but does not ascend into it. It begins to develop as a very low fold, hardly noticeable, and as growth proceeds its base does not expand antero-posteriorly, but tends rather to become narrowed so that it has a pedunculated form, as in Fig. 40. With the progress of this process, the margin of the fin-fold also becomes thinner at its distal border, and at the basal part mesodermal cells make their appearance more notably within the second or inner contour line of *bf*, Fig. 40. In some species I am quite well assured that there is at an early period a mesodermal tract or plate of cells developed just behind the auditory vesicles, just outside the muscle plates of this region, on either side, which may be regarded as the source of the mesodermal cells which are carried up into the pectoral fin-fold. This is developed at about the time of the closure of the blastoderm, and these lateral mesodermal tracts of tissue may be called the pectoral plates. The free border of the fin-fold grows out laterally and

longitudinally expanding the portion outside of the inner contour line of the fin, as shown in Fig. 40, into a fan-shape, so that the whole fin becomes much more distinctly pedunculated as viewed from the side. This distal thinner portion is at first without any evidence of rays, further than that there is a manifest tendency to a radial disposition of the histological elements of the fin. This radial disposition of the histological elements of the fin-substance has an undoubted relation to the growth in length and expansion of the organ and is conspicuously manifested in the development of the dermal lobes of the caudal fin of *Alosa* before the development of rays. The distal lamina, as we may call the thinner extremity of the fin, is the portion in which the rays are formed, while the thicker proximal or basal portion is that in which the basal elements of the fin are developed. Just at the point where the basal portion of the fin joins on to the body there is a decided fold extending up and down obliquely on the sides of the embryo and continuous with the fin; this may be called the oblique or vertical pectoral fold; just at the base of the fin and in this fold the coraco-scapular cartilage makes its appearance as a somewhat L-shaped plate, with its anterior coracoid limb extending forwards and downwards and its upper and scapular limb extending upwards. This is the first rudiment of the shoulder-girdle; the membrane bones which develop around it afterwards ectosteally, appear much later than in the stages so far described. The coraco-scapular cartilage I have studied most successfully in entire embryos of *Alosa* hardened in picric acid, cleared in oil of cloves, and mounted entire in Canada balsam.

As regards the detailed history of the development of the various ossicles of the pectoral fin I have little or nothing to record, further than to say that there is no evidence of a type of development like that seen in Elasmobranchs; the evolution of the breast fin of *Teleostei* being influenced by the specialized character of the limb-skeleton of the adult. The muscles are developed as in the Elasmobranch fin from mesoblastic strata of cells internal and external to the median plate, from which the cartilaginous axial portions of the fin are evolved. Sections through the pectorals of the larvæ of *Gambusia* show the details of muscular development to be very similar to that represented by Balfour in Fig. 346 (Comp. Embryol., II), as obtaining in *Scyllium*.

The next points of interest in this connection are the changes of position which the pectorals undergo in relation to the surrounding structures and their rotation upon their bases, by which they acquire an upright position so as to become mechanically effective as organs of propulsion or locomotion. At first quite longitudinal in direction, as shown in Figs. 32, 34, 40, and 42, the anterior portion tends to be gradually elevated as development proceeds, its base becoming more or less oblique in position as viewed from the side. Finally this process of the rotation of the base is carried so far that the fin acquires a nearly or altogether vertical position on the side of the body. The face of the fold

which was at first outermost is now anterior, and the face of the same which was innermost is now posterior. The displacement of the whole fin forward is not as real as would at first appear from our figures. The growth of the head and the elevation of the body have effected such changes in the relations of all the surrounding structures that the breast fins have not escaped its influence, and while it is unquestionably true that the breast fin has rotated on its base for an extent of almost ninety degrees, part of the apparent change of position is undoubtedly due to the concurrent development and increase in bulk of adjacent structures. The great gains in bulk which have taken place in the brain and body have had much to do with this alteration of the relative positions of adjacent organs.

The comparative embryology of the breast fins is very interesting, in that some variation in its relative position is evident upon studying a number of genera belonging to different families. In *Cybium* and *Parephippus* the primitive pectoral folds appear very far back or behind the vertical of the middle of the yelk-sack; in every other form with which I am familiar they appear farther forwards. In *Cybium* as many as twelve muscular somites may intervene between the point of origin of the breast fin and the auditory vesicle; in other forms the number of intervening muscular somites is usually less, being sometimes reduced to two or three (*Alosa* and *Pomolobus*). The homodynamic relations of the pectorals would therefore seem to vary greatly in the larval stages of *Teleostei*, and their serial relations to the gill arches are therefore also very variable. The unusual posterior origin of the pectoral rudiments of *Cybium* and *Parephippus* is also an indication that we may expect to find other anomalous modes of development, as indeed has been the case with some of the forms studied by Prof. Agassiz—*Lophius*, for example.

As to the development of the ventral or pelvic pair of fins I have observed little that is new, and can only call attention to the contrast in the development of the organs as observed in *Gambusia* and *Salmo*. In the latter the ventral fin-fold appears on either side about the time of hatching, a little way behind the yelk-sack, with its base horizontal, like the pectoral at first, and on a level with the lower wall of the intestine and just above the origin of the pre-anal* median natatory fold. In *Gambusia* it grows out as a little papilla, and not as a fold, where the body walls join the hinder upper portion of the yelk-sack a very little way in front of the vent. These two modes of origin are therefore in striking contrast and well calculated to impress us with a sense of

* Under the head of the median fins I find that inadvertently nothing has been said of the pre-anal. It is, however, developed in many embryo fishes, as in *Alosa* and *Pomolobus*, to the greatest extent, less so in *Salmo* and *Coregonus*, slightly in the later stages of *Cybium*, *Morone*, and *Parephippus*; it is wanting in *Gambusia*, *Cottus*, *Apeltes*, *Idus*, *Carassius*, *Tylosurus*, *Siphostoma*, and *Hippocampus*, and is absent in *Gadus* on account of the peculiar mode of termination of the intestine. It is also present in the larva of *Lepidosteus*, according to Agassiz.

the protean character of the means at the disposal of Nature to achieve one and the same end.

19.—The development of the lateral muscle plates and somites.

The lateral muscle-segments or somites of the body of the cod are developed, as in other fishes, by the transverse segmentation of the lateral muscle plates or somatopleures lying on either side of the neurula. The first evidence of muscle plates in the embryos investigated by me appeared about the tenth day, as represented in Fig. 23, *pv*. They appear mainly in succession from before backwards, the first pair developing a little way behind the auditory vesicles or the solid rudiments of the latter. As development proceeds, however, the most anterior pairs of muscular segments are differentiated later than those which first make their appearance on the sides of the body. As a rule, however, it may be said that they are segmented off in succession from before backwards towards the end of the tail, in which they last appear. A little while after the blastoderm of the cod's egg has closed, there are about eighteen to twenty pairs of muscle-segments distinguishable in the body of the embryo. In vertical transverse section across the body they are at first triangular, with the inner concave face applied to the side of the neurula. Like so many other portions of the embryonic fish during these stages, they are quite solid, and in sections the only evidence of a very well defined structure is their columnar stratum or external wall of cells. They are not all developed in the end of the tail until that part of the embryo has been fully formed. In the progress of the growth of the tail the muscular segments first appear in the proximal portion or that with which the body is continuous. But in the caudal region, after it has budded out, they have at first a different form from that observable in the first muscular segments of the body. They are here crescentic in transverse section, and not triangular as they at first were in the body. They clasp the chorda, neurula, and a ventral mesoblastic strand of cells, thus $\left(\begin{smallmatrix}\circ\\\circ\\\circ\end{smallmatrix}\right)$, on either side, the neurula being uppermost, the chorda in the center, and the mesoblastic strand of cells alluded to lowermost. At the tip of the tail, however, in its early stages of outgrowth, the whole of these structures are absolutely continuous; that is, blended and lost in an apical mass of cells in which no lines of demarkation can be made out. A little way forward the lines of separation between these structures become apparent, as may be seen in the tails of the embryos viewed from the side in Figs. 31 and 32. After the outgrowth of the tail the embryo's body has grown very notably in vertical thickness, upon which the muscle-segments of the body begin to assume the crescentic form seen on either side of the tail, except that in sections of the anterior regions the ventral limb of the crescentic muscular segments are truncated, resting with their blunt ends upon the splanchnopleure. With the growth of the body the mus-

cle-segments also increase in volume, and a perceptible increase in their length and width also takes place, as may be seen upon comparing their dimensions as shown at *pv* in Fig. 31 with those represented in Fig. 32. A very remarkable metamorphosis of their cells now begins to take place, by which they become stretched out as muscle-cells which correspond in length with the segments themselves. These muscle-cells also soon become transversely striated like voluntary muscle fibers generally, and have a distinct oval nucleus imbedded in their medullary substance, which may be very nicely demonstrated by the use of borax carmine. The primitive fibers also soon split up by processes of division into fibrils which are arranged in bundles, the fibrils themselves appearing in transverse sections as if they were arranged around a central empty space. With the progress of development, however, still other changes of form of the muscle-plates as wholes occur, and the first of these to be apparent is the >-shaped form they assume when viewed from the side of the body. They are then arranged thus >>>> in succession on either side of the body. The development of this last feature also proceeds from before backwards, being more marked at the anterior end of the body than at the posterior at an early stage. Still another point may be alluded to here relating to their arrangement: with the advance of development the anterior and posterior edges of the muscle-segments also become more and more beveled, the bevel trending backwards. On this account they finally overlap each other; that is, the hinder beveled margin of one segment covers the anterior margin of the succeeding one, which has its front edge beveled in the opposite direction. During the later embryonic stages still other changes occur in the relation and form of the segments themselves, when a smaller <-shaped portion is developed at the upper and lower margins of the individual plates, which open forwards instead of backwards, the reverse of the middle >, but which fit into each other in the same manner. The foregoing constitute the main features of the metamorphosis of the lateral muscle plates of the larval fish into those of the adult, and relate altogether to changes of form and histological constitution.

Another series of changes also occur, which effect the arrangement of the muscular plates into a dorso-ventral, lateral system. This is the division of the muscle-plates into two superimposed masses on either side, by the development of a horizontal ligamentous septum along the middle of the sides, and extending inward almost from the skin to the vertebral column. This lateral septum is continuous on its upper and lower sides with the intermuscular ligaments placed between the single pairs of muscular somites, producing the remarkable appearance of systems of rings of muscular tissue, arranged in a ventral and dorsal position on either side of the vertebral column, and well seen in a frozen section of the tail of an adult fish. The lateral and intermuscular septa produce, together with the peculiar bending and beveling of the mus-

cle-plates during development, the appearance of muscular cones in two lateral series, one above and one below the middle line of the side. These constitute the dorso-lateral and ventro-lateral systems of muscular plates. External to the dorso-lateral and ventro-lateral plates, differentiated as above described, on the middle of the sides, there is developed a thin strip of muscle, which in some adult fishes is quite distinct, especially when they are boiled, when it appears as a dark muscular band, in striking contrast with the white substance of the muscular plates or cones. These outermost plates of dark-colored muscle are developed during a late larval stage, and appear to be derived by delamination from the same somites from which the dorso-lateral and ventro-lateral plates have been differentiated. These dark lateral bands of muscle in the adult are segmented the same as the deeper plates, and their segments correspond in number and segmental position to the latter.

A very great difference in the downward extent of the muscle plates over the sides of the yelk-sack, is manifested in the embryos of different species of the same age. In the salmon and white-fish, the muscle segments extend for a considerable distance over the yelk-sack at the time of hatching, and after a variable time they completely inclose what remains of it. This is due partially to the collapse of the yelk, as it is absorbed, and partially to a downgrowth of the muscle-segments over the sides of the sack, between the epiblastic and splanchnopleural layers, the latter being carried along with the growth of the muscular layer. In other forms the whole of the sack may be absorbed before there is the least tendency of the muscle-segments to grow down and inclose it by their ventral borders. This is a noteworthy characteristic of the embryos of the shad, cod, Spanish mackerel, and other species, and again illustrates the singular way in which the young of a relatively homogeneous group may differ from one another. In the salmon the ventral development of the muscle-segments seems to be hastened; in the other cases it is evidently retarded. In the cod, for example, the edges of the muscle-plates do not even reach down so far as to cover even the upper lateral portion of the remains of the yelk-sack, as may be noticed in Fig. 49.

The material for the development of the posterior muscle segments of the embryo is also supplied in a singular way. In *Tylosurus* there is evidence of the concrescence of the rim of the blastoderm at the tail end of the developing axis of the embryo as may be surmised from an inspection of Fig. 6, pl. XIX, which accompanies my essay on the development of that form. The rim in this case does leave the embryonic axis at right angles on either side, as in the cod, as shown in Figs. 19 and 20 of this memoir, but at an obtuse angle after the time for the closure of the blastoderm is approaching. While there is a veritable caudal swelling it is also manifest that a veritable concrescence of the rim of the blastoderm is taking place by intussusception or gradual

appropriation of its cells to form the caudal end of the embryonic axis. When on the eve of closure, the limbs of the rim of the blastoderm in *Tylosurus* form an acute angle with each other, and the yelk blastopore has the form of a wide oval with the narrow end next to the caudal swelling. In *Elacate* the evidence in relation to the concrescence of the rim of the blastoderm in the middle line is very striking. Here, the limbs of the rim of the blastoderm on the eve of closure, where their substance is continuous with that of the muscle plates anteriorly, form an acute angle with each other, and there is no caudal swelling intervening between them as in *Tylosurus*. Not only is it evident in this case that an actual concrescence of the limbs of the rim of the blastoderm occurs, but it is also plainly evident that a transverse segmentation into segments has occurred in the lower layer of the limbs before their concrescence. The segmentation affects only the lower or somatic layer of the blastodermic rim and extends some distance behind the caudal end of the embryonic axis already formed. This is the only instance in which I have found evidence of a normal process of concrescence of the rim of the blastoderm along the median line in embryos of osseous fishes before the formation of the caudal plate. The concrescence, therefore, takes place also in the plane of the nervous axis as well as in the enteric. It would appear as if the yelk blastopore in such cases might be the true blastopore of the gastrula stage of development. It is remarkable, however, that I should meet with such a state of affairs only in *Elacate* and not in other forms, as regards the fate of the inner edge of the blastodermic rim. Only in *Elacate* have I ever met with any evidence of direct marginal apposition, concrescence, and convergence of the blastodermic rim on the eve of the closure of the blastoderm; in other forms it closes as a round pore, as in *Gadus*, *Cybium*, and *Alosa*, and segmentation into muscular somites of its lower layer never occurs during its closure to form the caudal plate.

In these ways the rim of the blastoderm is completely used up in the different species to form the caudal end of the embryo, the most of its substance being finally converted into the muscle-segments of the tail. But the growth of the tail outward is a most remarkable phenomenon, in that there is as yet in some forms no vascular system whatev r for the conveyance of nutrient matter, in spite of which the tail continues to elongate, evidently gaining bulk mainly to build up the lateral muscular masses the material for which must of necessity be transported outwards and backwards somehow from the yelk or other pre-existing tissue. The way in which this is accomplished is not clear to me except upon the theory of growth proposed by De Bary and Rauber. They regard cell-division as a consequence of growth, not growth a consequence of cell-division. Then, if we suppose with Rauber that cellular protoplasm has a structure consisting of vacuoles or lines radiating from a center, which favor intussusception of plasma from intercellular spaces, we may perhaps have an approximate explanation of

the process. I believe also that the segmentation cavity is a lymph space, and that, since the first blood-corpuscles are borne in it, the evolution of plasmine and fibrin may occur within it at an early stage and aid in such a process as the outgrowth of the tail, and thus indirectly in the development of its lateral muscles.

At the time of the closure of the blastoderm the number of muscle-segments developed in different species is also subject to considerable variation; so marked is this in extreme cases that it is proper to call attention to it in this connection. We find, for example, in many forms, not more than eighteen to twenty muscle-segments developed on either side of the body up to the time when the blastoderm closes over the yelk. In exceptional cases, as many as seventy-five may be developed, as we find in the instance of *Tylosurus*. This variation is doubtless due to the influence of heredity, the embryos which have the most segments at an early stage descending from adults which have a proportionally large number of muscular segments developed, while those embryos with but few are descended from parents with a less number.

The inclusion of the yelk-sack, or what remains of it at a late stage of development in young salmon, by the downgrowth of the ventral ends of the muscular segments overlying the sides of the abdomen, is a very interesting phenomenon. It recalls in some respects the process of inclusion of the yelk by the blastoderm at a much earlier stage. Unlike the latter, however, they do not coalesce at one point or come together as a round pore of gradually lessening diameter like the rim of the closing blastoderm, but they join on the median ventral line from the isthmus back to the pre-anal fin-fold; the opening which remains at this time between the ends of the down-growing episkeletal muscle plates has the form of a very elongate median, ventral cleft. The abdominal cavity in the young salmon is also relatively long in contrast with that of the young cod, but in larval Clupeoids it is of still greater relative length than in the salmon and proportionally longer than in any other forms known to me of the same stage. The downgrowth of the lateral muscle plates in all Teleostean types appears to take place in a somewhat similar manner to form the episkeletal muscular stratum external to the ribs.

20.—Development of the intestine and its appendages.

The development of the intestine of the *Teleostei* or true fishes is peculiar in a number of respects; these are, first, its primitively solid and depressed form, and secondly, the mode in which the oral end of it appears to be developed from behind forwards, there being apparently no clearly marked oral invagination of the epiblast or a stomodæum; thirdly, the mode of formation of the proctodæum or anus; fourthly, the appearance of a lumen in it not by a process of invagination from below or behind, but by a separation or retreat of its cells from its axis. Like the intestine of other vertebrates it is developed from the true

hypoblastic or nethermost embryonic layer, which is notably thickened at an early stage along the ventral side of the body of the embryo, but is still quite thin or almost wanting underneath the head; in fact it appears to be almost entirely undeveloped below the fore and mid brain at the time the blastoderm closes. Its condition shortly after the closure of the blastoderm in the embryo cod is shown in Fig. 31, at *i*, where its solid rudiment is visible as a band of cells underlying the notochord in the living egg. While its anterior extremity is not traceable to below the anterior end of the head, the posterior extremity is lost in the caudal mass at *i*, with which it is continuous. This relation of continuity of the hinder end of the intestine with the caudal mass shows that we must regard this condition as homologous with that observed in *Amphioxus*, Elasmobranchs, and other forms where the continuity of the neural canal at its posterior extremity with the intestine is effected through the intermediation of a short post-anal section of the latter or a neurenteric canal. This primitive continuity of the neural tube with the intestine has been so fully elucidated by Kowalewsky, Hatschek, and Kupffer that it is only necessary to refer to their memoirs on the subject and especially to the general treatise and the monographs of Professor Balfour. While I have found it impossible to convince myself by means of sections that there ever exists a neurenteric canal in embryos of osseous fishes, I feel assured that the solid nature of the posterior end of the neurula obscures this relation and prevents the development of it. This does not, however, permit us to deny the possibility of a primitive union of the enteric and neural tracts at the tail, and thus to realize a gastrula stage of development for the *Teleostei*. Kupffer has placed some observations upon record in regard to the connection of the vesicle named after him with the hinder part of the neurula. I have already remarked of Kupffer's vesicle that it is an evanescent structure, and of uncertain significance in relation to any organs developed afterwards. It has been observed by me in the ova of *Gadus*, *Alosa*, *Cybium*, *Tylosurus*, *Coregonus*, *Apeltes*, and two undetermined forms, so that it seems to be pretty generally present. In the cod its relation to the yelk blastopore *bl* is shown in Figs. 26, 28*a*, 29*a*, 29*b*, 30*a*, 30*b*, 31, and 32, at *Kv*. In 30*b* it seems to be joined by a fine canal to the blastopore, and in 28*a* it appears to be provided with a cellular wall. Its relations are, not, however, constant, as may be inferred from an inspection of the different figures in which it is represented as present. After the stage shown in Fig. 32 had been passed, I was no longer able to identify it with any succeeding structure which it could be supposed was derived from it. I therefore reserve my decision as to its true nature. In some forms it appears long before the closure of the blastoderm, in others coincidently with that phenomenon.

The great generalization, first distinctly formulated by Haeckel, that animals generally, pass, in the course of their development, through a gastrula stage, applies to the osseous fishes, and, notwithstanding the uncertain fate of Kupffer's vesicle, it is evident that the caudal plate,

with which the hind-gut and neurula are conterminous posteriorly, must in its mesial or axial portion represent the neurenteric canal, though an actual tubular intercommunication of the gut and neurula are never developed as in the embryos of *Amphioxus*. While, therefore, it is not yet possible to assert that there is a true gastrula mouth (prostoma) developed, in the embryos of *Teleostei*, we are in a position to say that, inasmuch as the rim of the blastoderm is used up in the formation of the caudal plate, which is taken up into the posterior portion of the body, the true blastopore probably coincides with the last portion of the solid neurula, to be formed at the anterior border of the yelk blastopore, and cannot be identified with the latter itself. The latter is not, therefore, homologous with the blastopore of the frog's ovum. I cannot accept the views of Zeigler in regard to the homologies which he has sought to establish between the whole of the Teleostean and amphibian ovum, for reasons relating partly to the history of the blastopore and partly on account of considerations which arise from a study of the fate of the yelk.

In embryos of the cod on the sixteenth day of development, Fig. 32, the intestine has made a very notable advance in differentiation as compared with the stage shown in Fig. 31. In the anterior portion it has barely acquired a lumen, and is still much depressed; but farther back from a little in front of the breast fin to the vent *v* it has gained in vertical thickness very notably, become more cylindrical, and has acquired a central cavity. Its anal end apparently terminates upon the yelk. Just opposite the pectoral fin-fold *ff* the ventral wall of the intestine is becoming quite thick in the vicinity of *lv*. This thickening represents the rudiment of the liver, which appears in the cod, as in other fishes, to be at first a solid outgrowth from the intestine. The condition of the intestine on the sixteenth day, as in Fig. 32, is gradually followed by a more advanced state, such as that shown in Fig. 34, taken from an embryo on the nineteenth day of incubation. It is shortly after or at about this stage that the anal end of the intestine is carried outwards to end in the ventral fin-fold, some distance above its margin, as shown in the just-hatched embryo represented in Fig. 40. The rudiment of the liver in Fig. 34 has been more fully developed, and now projects as a lateral, ventral and dorsal thickening of the intestinal wall at *lv*. It has not yet apparently acquired a lobulated structure, such as afterwards becomes apparent in more advanced stages. As the development of the liver proceeds it becomes gradually more conspicuous as a lobulated organ on the left side of the intestine, but is reflected around the latter above and below, as shown in Fig. 40. From the time of hatching onwards the intestine gradually acquires a spacious lumen, but no greenish biliary secretion was noticed in it, such as is commonly observed at this stage in embryos of *Cottus*, *Salmo*, etc., of the same age. It is singular that the secretion of bile in fish embryos should precede

the injestion of food; this secretion in such embryos is probably analogous to the meconium discharged by recently born infants.

Meanwhile the lumen of the œsophagus, pharynx, and mouth are being differentiated. In sections at this stage the œsophagus has a lumen, and is not solid, as Balfour states (Comp. Embryol., II, 63), but is depressed or cylindrical at its hinder part, while beneath the head it rapidly widens, where its width exceeds its depth several times. In the cod, however, its anterior flattened portion is short, and is not so extended as the same part in embryo Clupeoids. This flattened anterior portion of the mesenteron is molded upon the lower face of the brain, and is concave from side to side on its upper surface and convex from side to side on its lower. Its walls are very thin in contrast with the more posterior portion of the intestine or mesenteron, and are hardly more than one layer of cells deep in places. In longitudinal sections of embryos of the Clupeoid *Alosa*, in which the mouth is just about to break through, the most anterior or hyomandibular cleft which intervenes between the hyoid and mandibular arches seems to be the most developed, but it does not appear to break through the skin. Behind this the six gill-clefts are developed on either side of the pharyngeal portion of the fore-gut. They appear to be of the nature of narrow lateral paired outgrowths from the sides of the depressed fore-gut, and have at first only a very narrow cleft-like lumen. The gill-clefts are at first very much crowded together antero-posteriorly in the young just-hatched cod, as may be gathered from Figs. 40, seen from the side, and 46, viewed from below, where the gill-clefts are shown at *g*. Dohrn holds that the mouth is to be regarded as an anterior outgrowth of the mesenteron from behind forwards, that it is divided in the middle line, and that the two limbs of the larval mouth grow out laterally and separately. He also seems to regard these paired oral outgrowths as the first of the branchial clefts, counting the second as the hyomandibular. As already stated, I have not been able to fully convince myself that this is the fact, although I have seen evidence in a series of sections of embryo Clupeoids which have inclined me to think Dohrn's view the correct one.

The mouth breaks through in or near the angle formed by the lower fore part of the head and the anterior epiblastic wall of the yelk-sack at the point *m* in Fig. 40. In *Alosa* the point where the superficial external epiblast is continued into the oral hypoblast is exactly in the angle alluded to above, and, as far as I can make out from longitudinal sections, there is no clear evidence of a distinct epiblastic oral invagination or stomodæum, such as is found in *Petromyzon*, for example. As development advances, the upper lip grows forward in advance of the end of the lower jaw to a marked extent, exposing the roof of the larval mouth considerably. The lower jaw, after this, begins to elongate, and soon grows in length so as to regain what it had apparently lost in relative length as compared with the upper. It is during the early stages, before the outgrowth of the lower jaw, that the mouth gapes, the man-

dible being short and immobile. After the mandible has grown to be of the same length as the upper it first begins to show signs of mobility, though it is not until some days after incubation that the jaws of the embryo begins to move, and then mostly rhythmically in respiration, the water being sucked in through the mouth and passed through the gills, the same as in the adult. Only after the young fish have the jaws distinctly developed, as in Fig. 49, do we begin to note that there are voluntary snapping movements of the mandible manifested.

At the time of the birth of the young cod there is no circulation of the blood; there are no blood vessels, in fact; which accounts for the non-functional development of the branchial apparatus at this period. The function of respiration at the time of exclusion and for some time thereafter, as during development within the egg, is apparently performed by the skin, which presents a large amount of surface, as may be seen in Fig. 40. Not only is this true, but the skin itself in the living embryo of this stage is lifted off perceptibly from the underlying structures, as shown in Figs. 42 and 43. This subdermal space, filled with fluid, probably a serum, is of the nature of the serous space around the yelk, and doubtless has a respiratory in addition to an assimilative function. The existence and office of such spaces in embryos have hardly received the attention they merit; they probably represent the earliest and most unspecialized contrivances for the transfer of pabulum in solution, in the form of paraglobulins, fibrins, or other plastic matters, from one part to another of a nascent organism.

The intestine during the later stages of development is gradually separated from the notochord at its hinder extremity by the interposition between the former and latter of more and more tissue, mostly of a mesoblastic character, which can scarcely be accounted for except upon the supposition that in each and every cell of the embryo there inheres a power of growth dependent again upon the intussusceptive powers of the cells themselves, by which they are enabled to appropriate soluble plasma through their neighbors or by way of intercellular or the extensive serous spaces already alluded to. The gradual evolution of the embryo fish before there is the slightest evidence of a systemic circulation forces the foregoing conclusion upon the student. He sees, for example, a germinal disk, at the commencement of development, of a determinate form and size, but it is not long before he begins to discover that additional material from the yelk has been added to the embryo, the bulk of the embryo itself perceptibly surpassing in size the original bulk of the disk from which it took its origin. This has been accomplished, too, in all cases, before there is a trace of circulation; in fact, before even the heart has begun to pulsate. It is this gain in bulk of the embryonic structures above and beyond the original mass of the germinal disk which cannot be accounted for on any other hypothesis, as pointed out by Rauber. The segmentation cavities of the ova of various types accordingly acquire a profounder meaning than has

hitherto been generally ascribed to them. They are, in fact, the primal representatives of nutritive spaces—lymph cavities; perhaps even of the food and water vesicles of *Protozoa.*

On the twenty-seventh to the thirtieth day of development, as shown in Figs. 49 and 45, respectively, the regions of the intestine for the first time begin to be clearly mapped out. In Fig. 49 the depressed œsophageal portion of the alimentary canal ends just over the lower lobe of the liver *lv* and just in front of what appears to be its upper portion *y*. In front of *y* there lies a body, covered with large stellate pigment cells, which I have identified with the air or swim bladder. Its mode of origin I have not made out in the young cod, but in *Gambusia* and *Alosa* it is a distinct dorsal diverticulum of the intestine, which arises a little to one side of the median line. Its hinder end is prolonged backwards with the advance of development, and is at first a small and inconspicuous structure, with a thick wall, which, on its ventral face, may be lined by what appears to be glandular epithelium, as in *Gambusia.* The connection of the pneumatic diverticulum with the intestine is by a narrow open canal, which may remain open in the adult, as in physostomous forms, for example, where it forms a pneumatic duct, or it may be aborted during a post-larval stage, as in the physoclistous species.

Behind the liver and air-bladder the intestine becomes suddenly widened, as shown in Fig. 49, and has its internal surface elevated into low folds or papillæ, which are the rudiments of the gastric and intestinal follicles of a later stage. This widened portion of the intestine is continued backwards until a constriction is encountered at *ic*. From the liver back to the constriction alluded to, the middle portion of the intestine later becomes the stomach. The constriction is apparently the pylorus and pyloric valve, while the section of intestine from the constriction to the vent *v* becomes the hind-gut of the adult, with an almost uniform caliber throughout.

Peristaltic action of the intestinal wall shows itself very early in fish embryos, or about the time that the three regions are distinctly marked out as described above. I have frequently witnessed its manifestation in newly hatched shad, and also when they were a few days old and had begun to take small crustaceans as food. The peristaltic contractions of the intestinal wall would push back the food to about the point where the œsophagus ended and where the liver began, and where the intestine was considerably widened. This widened portion was then continued back to a similar pyloric constriction, beyond which I but rarely saw the food carried.

The histological features of the intestinal walls of embryo fishes are interesting in that it is the mucous or epithelial layer which is principally developed. The muscular layers, both the longitudinal and annular, are thin. The latter is pretty thick in embryos of *Salmo.* In the neighborhood of the commencement of the stomach in embryos of *Alosa* the mucous pits and folds of the enteric epithelium are most pronounced

and thickest. Here, probably, we have the first evidence of the development of true gastric follicles. Of the development of the pyloric appendages I can say nothing more than that they, like the liver, are undoubtedly diverticula of the intestine, but which evidently develop much later than that organ, for in no form studied by me had they made their appearance up to the time, and even as late as two weeks after, the yelk was absorbed.

The vent of young fishes at first ends blindly. At the very moment the tail begins to bud out as a little rounded knob-like prominence the anal end of the gut breaks its continuity with the caudal mass of cells, and its blind extremity is directed straight backwards. Meanwhile the rest of the tail continues to grow backwards in length, leaving the anal end of the gut in the angle formed between the lower border of the tail and the yelk-sack, as shown in Fig. 40. In transverse sections of the tail of embryos a little younger than that shown in Fig. 32, a ventral strand of cells may be seen which appear to have been continued backwards from the anal end of the gut into the caudal mass of cells, but it is difficult to assure one's self that they inclose a canal which would answer to a post-anal section of the intestine, the homologue of the neurenteric canal. At this stage the anal end of the gut is sometimes club-shaped, and may end apparently on the yelk, as in the young cod, or may soon be slightly prolonged backwards and ventralwards between the thin dermal and splanchnopleural layers to end in an emargination at the edge of the ventral median fin-fold. This mode of termination is the usual one, and, so far as I am aware, the embryo cod is the only exception to it. Here, instead of ending at the margin of the fin-fold, the vent does not grow out so far, but ends within the margin of the fin-fold and some way from it, as may be seen in Figs. 40, 45, and 49. Moreover, with the outgrowth of the tail there is no marked accompanying prolongation of the hind section of the gut, such as we may note in young of *Salmo*, *Coregonus*, *Alosa*, *Pomolobus*, and *Clupea*. In these forms as the growth of the tail proceeds the anal end of the intestine, on the contrary, makes an accompanying growth in length backwards, by which the vent is pushed farther and farther back from the posterior end of the yelk-sack. Another type of development of the hind-gut of the embryos of osseous fishes is met with in *Cybium* and *Parephippus*, where the hind-gut grows out to the margin of the ventral fin-fold, but is not prolonged backward behind the yelk-sack, in consequence of the subsequent growth in length of the tail. With the collapse of the yelk-sack, however, in these two genera, the pre-anal fin-fold lengthens; this lengthening of the latter fold is, however, wholly ascribable, to the collapse of the yelk-sack, and not to any backward growth in length of the tail as a whole.

Of the development of the spleen and pancreatic tissues I can add nothing to what is already known, which is very little, except that in *Gambusia* I have met what may possibly be a splenic rudiment behind

the liver, and partially enveloping the hind-gut, in embryos which had not yet absorbed the yelk-sack. The pancreatic tissues of fishes seem to be intimately bound up with the history of the pyloric appendages, and we may therefore expect to know more of them when the development of the cæca has been worked out.

21.—DEVELOPMENT OF THE RENAL ORGANS OR CORPORA WOLFFIANA.

The remarkable researches of Semper, Balfour, Sedgwick, Fürbringer, Rosenberg, Œllacher, and others, on the early history of the kidneys of vertebrate embryos has within a comparatively recent period thrown a flood of light upon what had previously been a most obscure and poorly understood subject. While it will not be possible for me to add much to the general principles of development of the renal organs, so ably worked out by my predecessors, and in many senses my monitors, I can add here what I have observed in the development of those organs in *Gadus*, *Alosa*, *Gambusia*, and *Salmo*, bringing out some singular peculiarities in the evolution of the mesonephros or wolffian body itself as manifested in the embryos of these different genera.

In the figures accompanying this memoir I have not represented the segmental ducts, except in Figs. 46, 49, *pnp*, and in a diagrammatic cross-section, Fig. 33, *sd*. The details, which I have mainly worked out by means of sections of the embryos of various other genera, I reserve for illustration and description in future special essays upon those types. The development of the renal organs in different genera of *Teleostei* differs greatly in detail, as we shall learn further on. The following general description of the development of the segmental ducts or pronephros seems to apply to osseous fishes generally:

At about the time the tail begins to bud out and the muscular somites of the body have been formed, the segmental ducts are folded off from the splanchnopleure or peritoneum as a pair of longitudinal canals on either side of the middle line, as shown at *sd*, Fig. 33. They lie in close contact with the peritoneal wall of the abdomen, and at their anterior ends they open freely into its cavity. They are also usually bent upon themselves more or less markedly, inwards and backwards, and then forwards again, as shown in Fig. 46, from below, at *pnp*, and in Fig. 49. These are the primitive open funnels or free anterior extremities of the pronephric or segmental ducts as we see them in the living cod embryo of a late stage. In the young cod, some days after hatching, their anterior ends are found to lie on either side of the front end of body, extending forwards to near the auditory vesicles, and as development advances they seem to approximate the latter more closely. Traced backwards, the segmental ducts pass over the peritoneum almost exactly parallel to each other till they converge and join the allantoic or urinary vesicle *al*, conspicuously shown in Figs. 40, 45, and 49. The exact mode of their union with this vesicle I have not learned in *Gadus*, but it prob-

ably occurs at the posterior dorsal part, as in *Cybium*. The allantoic or urinary vesicle opens either into a cloaca or into the extreme hinder and possibly cloacal portion of the anal end of the intestine, as in *Alosa*, *Salmo*, and *Hippocampus;* a cloaca is, however, probably fully developed at a later stage, into which the generative ducts, bladder, and intestine open. Upon the development of the cloaca I have made very insufficient observations, and whether it is developed from the anal end of the larval intestine and lower end of the allantoic sack I am not able to state. While in some forms there is an emargination of the ventral fin-fold where the intestine ends, there is as yet no common external depression in which the alimentary, genital, and urinary canals terminate; this structure must therefore be relatively late in developing.

The segmental ducts are simple, straight cylindrical canals throughout, except at the anterior extremity, the walls of which are composed of a single layer of cells. They constitute the simplest expression of the renal excretory system of the vertebrates, and are not provided with any Malpighian bodies or other accessory excretory organs at the stage of development now under discussion, as there is as yet no circulatory system to supply blood to any glomeruli, even if these were developed. The only place where it may be supposed that anything like a glandular character has been acquired by the organ, is at its anterior end, where it is bent upon itself in the peculiar manner already described. The diversity of manner, however, in which we find the accessory organs developed in the adults of different genera, as well as the relatively late or early development of these structures in different forms, is no less interesting than the fact that the glandular portion is at first formed in different regions in the embryos of dissimilar genera. For instance, *Salmo* is in marked contrast with *Gambusia* in that the mesonephric glomeruli are developed from a little behind the pectoral fins almost to the allantoic vesicle or urinary bladder even before hatching, while in the latter genus the mesonephric portion is quite anterior, and is crowded forward against the auditory vesicle. In still other instances the pronephros does not extend nearly as far forward as in either of these cases; of this we have an illustration in the embryos of *Alosa*, where the pronephros ends far short of the head, but its anterior termination is similar in form to that observed in other families. Balfour has noticed some of the conditions of the organ in the adults, and he observes (Comp. Embryol., II, 579): "In some cases the cephalic portion of the kidneys is absent in the adult, which probably implies the atrophy of the pronephros; in other instances the cephalic portion of the kidneys is the only part developed." This has its significance, and it is important that the peculiarities of different genera in respect to the mode of origin of the renal organs be investigated. In *Alosa* there is no evidence of glomeruli on the inner side of the segmental ducts until long after hatching; such also appears to be the case with *Gadus*. In *Gambusia* and *Salmo*, on the other hand, the segmental tubes are already developed, in the first case

in the head region, and in the last along almost the whole length of the ducts at the time of hatching. In *Gambusia* the segmental tubules form a complex, convoluted mass just behind and partly below the ear, and is richly supplied with blood long before the young have absorbed the yelk-sack or have been discharged from the ovarian follicles of the parent. Along the segmental ducts or pronephric canals, behind this point, there is no evidence of tubules whatever, yet in the adults of *Gambusia* we find the Wolffian body or kidney extending dorsally along the whole length of the body cavity. No such complex head-kidney, as we may call the structure found in the embryos of *Gambusia*, is developed in the young of *Salmo*, even at the time of hatching, although segmental tubes have already been formed. An examination of *Alosa* of the same relative age shows that absolutely no segmental tubes or accessory glomeruli are developed. To what cause are we to assign this difference? The cause is apparently a physiological one, and is probably not due to any phylogenetic influences, except as these may be expressed in an accelerated or retarded state of development of the systemic circulation. Both in *Gambusia* and *Salmo*, of the stage of development here considered, the blood vascular system is already far advanced, while in *Alosa* and *Gadus* there is still no circulation; this seems to me in part at least to offer an explanation of the great differences observed in the development of these organs in the embryos of the same age of different genera. As regards the local or general development of the mesonephric structures along a part or the whole of the segmental ducts, that difference is of course probably to be ascribed to hereditary or phylogenetic, and not to physiological influences.

The value of the evidence regarding the opening of the glomeruli into the body cavity will depend altogether upon what is meant by the latter term. If it is held, as it is by me, that the body cavity of fish embryos is the same as, or is at first continuous with, the segmentation cavity, then the glomeruli, as far as I am able to interpret my sections, are shut off from the body cavity. This is the view also which I should take of the sections figured by Balfour, Zeigler, and Œllacher. The segmental tubes are probably developed, like the glomeruli, from mesoblast, which lies above the peritoneal layer and between it and the aortic and venous vascular tract. In sections through the pronephros of *Alosa* it has appeared to me as if it opened anteriorly into the body cavity, but I could see no evidence of a glomerulus; but this, it is to be remembered, was in embryos which had not yet developed a circulation. The peritoneal or splanchnopleural layer is well marked in embryo fishes, but it does not usually extend far out over the yelk in early stages, so that it is easy to see that it cannot include the yelk. The true hypoblast, after the development of the intestine in *Alosa*, seems to have vanished as a discernible layer, so that the gut lies directly upon the yelk, and is therefore bounded on either hand by the segmentation cavity, which is naught else but the body cavity itself, which diminishes in

size as the yelk is absorbed. This relation of parts is merely pointed out here in defense of the position which has been assumed in regard to the non-connection of the glomeruli with the body cavity, and will be again alluded to in its proper place.

22.—The development of the heart.

The development of the heart of the young cod is typical of that process in young osseous fishes generally, with this qualification only, that, like the history of other portions of the body, the details of it differ considerably in the embryos of different genera. The earliest evidence of its presence is represented in Fig. 30, showing the under side of the head of an embryo of fifteen days. Large cells have first arranged themselves in a transverse band-like layer below the fore-gut; the latter is not represented in the figure. This layer is continuous with a stratum which is continued forwards on either side of the fore-gut and mid-brain, and forwards in front of the eyes and below the fore-brain. It is mesoblastic, and the only portion of it which has crept around to below the fore-gut is the transverse band in which the heart develops. Sections through the heads of embryos in similar stages of other genera justify the foregoing description. This mesoblastic stratum is also continuous with the posterior pericardiac septum *pc*, just behind the heart, while at the extreme anterior end of the head it contributes to the formation of the trabeculæ cranii and rostral plate or cartilage, and behind and above the gut it shares in the development of the parachordal sheath. In the extremely early stage of heart development shown in Fig. 30 the cavity of the future heart is a circular opening *h* in the plate of cells, from which the organ is formed by growth in length. It now appears to be wider than deep, but it gradually elongates, and instead of its axis remaining vertical to that of the long axis of the head, it grows forward more or less horizontally, as seen in Fig. 29, where the head of a seventeen-days embryo is viewed from below. Its anterior extremity now widens into a funnel shape and begins to pulsate very slowly and irregularly—once or twice in a minute, perhaps. Its anterior, apparently open end is not free, however, as might be supposed from an inspection of the figure, but is continued into an exceedingly delicate, thin membrane, continuous behind with the pericardiac septum. It will also be noticed that in Fig. 29 its front end is bent to the right side. This lateral bending is continued during the progress of development, and finally when the embryo is hatched it opens backwards, as shown in Figs. 40, 42, and 46, and also in 41, as viewed from the side, where the primitively anterior end is shown at *sv*. What was the lower side of the cardiac plate in Fig. 30 has grown downwards, then forwards, then is bent to the right, as in Fig. 26, then still more in Fig. 42, till, as viewed from the side in Fig. 41, the heart tube forms a loop with what was formerly the front end directed backwards and upwards and joined to the pericardiac membrane. It has now passed through the following stages: First, it has the form of

a plate of cells; secondly, its cavity appears as a round opening in the plate; thirdly, it grows in length so as to form a nearly straight tube; fourthly, it bends upon itself so as to carry its venous end upwards and backwards; fifthly, it is differentiated into three distinct regions, as shown in Figs. 41, 42, and 46. In freeing itself and becoming tubular, a serous space is formed around it; the pericardiac space, which is continuous, at least by way of the open venous end of the heart with the segmentation cavity, from which also the fluid filling the heart and pericardiac cavity appears to be derived. Not unfrequently colorless blood cells or white corpuscles may be seen in both the segmentation and pericardiac cavities during this stage and later, which are moved or swayed in their bath of serum by the pulsatile action of the heart. These phenomena may be observed in numerous species, and seem to be a normal accompaniment of the development of the Teleostean heart. The presence of now and then a colorless blood cell in the pericardiac cavity during the early stages of *Gadus*, and even of colored ones in the pericardiac spaces of *Salmo* and *Tylosurus*, shows that this cavity is not wholly shut off from the yelk hypoblast ("*couche hæmatogéne*"), and therefore not altogether discontinuous with the segmentation cavity. In *Elacate* the segmentation cavity extends under the head, back towards where the heart originates, and so close to it that a relation of continuity seems altogether probable at an early stage. The thin veil-like fringe shown at the posterior end of the heart of the young cod in Fig. 41 I have found in longitudinal vertical sections of the recently-hatched embryos of *Alosa* to be actually continuous with the exceedingly thin pericardiac membrane below and behind the heart, the venous end of the organ actually opening through it into the segmentation cavity. The latter is regarded by me as synonymous with the body cavity; so that the body cavity itself is derived from the segmentation cavity. The body cavity is divided from the heart or pericardiac space by the posterior pericardiac membrane, which is developed concurrently with the heart itself. The pericardiac membrane incloses the heart space ventrally and posteriorly and is of splanchnopleural origin. In *Alosa* sections through it show it to be a membrane of filmy tenuity, with nuclei imbedded in it here and there. It is much thinner in that species than even the outer epiblastic covering of the yelk-sack. In *Gadus* it is a transverse fold of notable thickness, during the early condition at least, or off the middle line of the body, as shown in Figs. 30 and 46.

The differentiation of the heart tube into regions is a gradual process; the first portion to be marked off is the dilated anterior end or venous sinus, then the ventricle and bulbous aortæ. A glance at Figs. 29, 46, 42, and 41 will show the steps of the process; how the heart tube has been bent upon itself in shifting the venous end round to its final oblique position in the middle line. I have not been able to make out the double tube or one within the other, as represented by several investigators. Doubtless there is an outer pericardiac layer, but neither in

the living heart nor yet in sections of it have I succeeded in making it out; at most it must be very thin, like the pericardiac membrane itself. Moreover, the whole of the cardiac walls are contractile, as seen in the living embryo. The contractility of the heart at an early stage is a very remarkable phenomenon, in that it as yet contains no clearly marked, spindle-shaped muscular cells or fibers; the contractility manifested during its early phases is apparently almost an automatic process, the stimulus for which may or may not proceed from any splanchnic nerves. It would appear that the nervous system during this early stage was hardly well enough developed to take part in the stimulation of the organ. I never saw any knot of nervous matter on it, or in its vicinity, which I can identify as a cardiac plexus or ganglion, and traceable as an appendage of the tenth or vagus nerve.

With the advance of development the blood is also formed, but not until about ten days after hatching; meanwhile, the heart has also assumed its final position in the median line; the venous end is no longer swung slightly to the right side, but occupies an antero-posteriorly inclined position in the middle line, as shown in Fig. 49. Its walls, especially those of the ventricle *h*, have become thicker, but there are as yet no muscular pillars or partial septa developed in it, as we find in the ventricle of *Cottus* and *Alosa*. The valves, also, cannot be said to be developed as folds, such as we see in the adult. The office of the valves seems to be performed solely by the rhythmical constriction of the cardiac tube at definite points. First, the venous sinus fills with blood, which is still pale and comparatively rich in serum; then the atrio-ventricular valvular constriction opens, and the blood is forced, by the contraction of the walls of the sinus, into the ventricle, when the intervening constriction again closes, and confines the blood in the ventricle, from whence it passes, by a similar process, into the bulbus, and so into the branchial vessels. I do not mean to imply, however, that the contracted portions of the heart-tube do not mark the regions where valves will appear in future, nor to convey the impression that the regions where the rhythmical valvular collapse of the cardiac tube occurs during pulsation are not constant in the embryonic hearts of young fishes. All of the cardiac compartments appear to exhibit pulsations even to the bulbus, which, according to Huxley (Anat. Vertebrates, 140), is not rhythmically contractile in the adult. True, the walls of the embryonic bulbus are thin, like those of the sinus, and it may be that its dilatations and contractions are simply an effect of the distension produced by the rhythmical contractions of the ventricle. The effect of the pulsations of the ventricle upon the blood current are visible at a late stage, just as we see in the circulation of the gills of the salamander or the web of a frog's foot; what is here meant is that the blood flow is not at a uniform rate, but the current in the vessels moves slightly slower and faster alternately, owing to the alternate exertion and non-exertion of the propelling power of the heart during the diastole

and systole of the ventricle. These phenomena are well known to physiologists, and some of their effects are matters of every day class demonstration, upon man and the higher animals, by means of the sphymograph; in other words, the fish embryo has a pulse.

It has already been remarked that wide differences of cardiac development occur in different genera and families of osseous fishes. Take the case of *Idus melanotus*, the golden ide; in the embryo of this species the venous end of the heart grows down between the front end of the yelk and its epiblastic covering until the heart itself lies ventrad of the anterior part of the yelk-mass. The Cuvierian ducts, which collect the blood from the cardinal veins, actually pass around the front end of the yelk on either side, and join the venous sinus below it; besides these venous vascular arches there is no circulation over the yelk-sack in this species.

In *Tylosurus* the venous end of the heart is prolonged in front of the head of the embryo into an annular vessel which traverses the entire circumference of the yelk in a plane coinciding with the axis of the body. Later two vessels arise from the cardinal veins which carry the blood from the body over the yelk back to the outlying venous end of the heart. Then below the head a huge pericardiac space or chamber is gradually formed, which is roofed over entirely by the epiblastic covering of the yelk-sack into which the heart depends, having been disproportionally elongated in consequence. Its venous end is fixed to the extreme lower part of the huge heart chamber where it is continuous with the yelk hypoblast or blood-generating layer which overlies the yelk. Here at its point of attachment the three vitelline veins join the heart and pour their contents into it. The remarkable abundance of blood corpuscles in the heart cavity and their origin has already been described in my paper on this species, so that I will not here repeat what has already been well enough elaborated elsewhere.

In *Apeltes* the venous end of the heart is pushed out from the right side of the body and is at first joined to an asymmetrical system of vitelline vessels, which at a later stage become quite symmetrically arranged.

In *Salmo* the heart is never prolonged outwards anteriorly or laterally in the embryo, as in the foregoing species. The vitelline system of vessels develop somewhat asymmetrically, and the great venous vitelline trunk does not lie in the middle line but somewhat to the left side. A part of the blood which passes through the vitelline capillaries passes through the liver, and there are no greatly developed representatives of the Cuvierian ducts which traverse the yelk-sack, as in *Idus* and *Tylosurus*.

In the young gold-fish, *Carassius*, the Cuvierian ducts embrace the anterior extremity of the yelk as in *Idus*, in order to reach the heart, which is ventrad of the yelk in position.

In *Siphostoma* a subintestinal vein passes down behind the yelk-sack and traverses its ventral surface in the middle line to empty into the heart in front, which does not have its venous end prolonged but simply opens to this median vessel in a ventral direction.

The embryos of *Fundulus* have the heart somewhat prolonged over the yelk anteriorly.

In *Gambusia*, a diffuse, superficial, vitelline capillary system arises from a very short subintestinal vein and lateral venous trunks which are probably Cuvierian, but which are also assisted by the hepatic vein on one side. The capillaries so arising converge at the anterior end of the yelk, where the venous end of the heart is prolonged downwards between the epiblastic covering of the yelk and the yelk hypoblast.

In the cod, when the blood-vessels are developed, thirty days after hatching, the venous sinus opens upwards and backwards and receives three sets of vessels, viz, lateral and ventral intestinal and the cardinal veins, the latter by way of the Cuvierian ducts.

In *Cottus* a pair of anteriorly divergent veins, lying on the ventral face of the yelk-sack, pass upwards and forwards to empty into the venous sinus, just below where the cardinals debouch.

Alosa, *Cybium*, *Parephippus*, *Elacate*, *Osmerus*, and *Pomolobus* do not have a vitelline circulation at all, and here the heart soonest acquires its adult position, as in the cod. But in all of these forms it is in the highest degree probable that the heart opens directly into the segmentation or body cavity, as I have demonstrated in *Alosa* and *Pomolobus*. The mode of absorption of the yelk in these forms also becomes clear on the grounds already stated in my paper on that subject, namely, by direct gemmation of corpuscles from the yelk hypoblast into the segmentation cavity, from whence they are taken up into the circulation by the heart.

23.—Development of the circulation and the function of the yelk hypoblast.

The various physiological adaptations of the circulatory system, if we may so speak, which we have described in the preceding chapter, show us clearly that one and the same function may be performed by the profound, almost radical, modification of the system of organs which is concerned in its manifestation. In no set of organs within a restricted group of types do we find any instance which presents more striking variations than those observable in the arrangement of the vessels upon the yelks of different species of embryo Teleosts. To trace the course of the vessels themselves in the different forms to be described is no easy task; this will therefore not be attempted with the less important ones, but only with the larger vascular trunks, which are also the first to be developed.

The development of the vessels themselves is so important for us to

understand that I shall here reproduce what Balfour has said of it in his Comparative Embryology, II, p. 519:

"The actual observations bearing on the origin of the vascular system, using the term to include the lymphatic system, are very scanty. It seems probable, mainly it must be admitted on *à priori* grounds, that vascular and lymphatic systems have originated from the conversion of indefinite spaces, primitively situated in the general connective tissue, into definite channels. It is quite certain that vascular systems have arisen independently in many types; a very striking case of the kind being the development in certain parasitic *Copepoda* of a closed system of vessels with a red non-corpusculated blood (E. Van Beneden, Heider), not found in any other Crustacea. Parts of vascular systems appear to have arisen in some cases by a canalization of cells.

"The blood systems may either be closed, or communicate with the body cavity. In cases where the primitive body cavity is atrophied or partially broken up into separate compartments (*Insecta*, *Mollusca*, *Discophora*, etc.), a free communication between the vascular system and the body cavity is usually present; but in these cases the communication is no doubt secondary. On the whole it would seem probable that the vascular system has in most instances arisen independently of the body cavity, at least in types where the body cavity is present in a well-developed condition. As pointed out by the Hertwigs, a vascular system is always absent where there is not a considerable development of connective tissue.

"As to the ontogeny of the vascular channels there is still much to be made out both in vertebrates and invertebrates.

"The smaller channels often arise by a canalization of cells. This process has been satisfactorily studied by Lankester in the Leech,* and may easily be observed in the blastoderm of the chick or in the epiploon of a newly-born rabbit (Schäfer, Ranvier). In either case the vessels arise from a network of cells, the superficial protoplasm and part of the nuclei giving rise to the walls, and the blood corpuscles being derived either from nucleated masses set free within the vessels (the chick), or from blood corpuscles directly differentiated in the axes of the cells (mammals).

"Larger vessels would seem to be formed from solid cords of cells, the central cells becoming converted into the corpuscles and the peripheral cells constituting the walls. This mode of formation has been observed by myself in the case of the spider's heart, and by other observers in other invertebrata. In the vertebrata a more or less similar mode of formation appears to hold good for the larger vessels, but further investigations are still required on this subject. Götte finds that in the frogs the larger vessels are formed as longitudinal spaces, and that the walls are derived from the indifferent cells bounding these spaces, which become flattened and united into a continuous layer.

* Quart. Journ. Mic. Science, Vol. XX, 1880.

"The early formation of vessels in the vertebrata takes place in the splanchnic mesoblast; but this appears to be due to the fact that the circulation is at first mainly confined to the vitelline region, which is covered by splanchnic mesoblast."

Has it, however, been proved that a splanchnic layer covers the yelk of fishes at a late stage, or after the inclusion of the yelk by the blastoderm? The reply to this is most positively in the negative in the case of those forms devoid of a vitelline vascular system. In those types, however, in which a vitelline system of capillaries is found, the answer is not so clear. Sections of the salmon, just after hatching, are very instructive, and we here find an arrangement which is most interesting, especially if those through the region of the liver be examined, from the ventral border of which it is evident that vessels are continued directly over the yelk, and that if they are not wholly channeled out of the thick plasmodium or yelk hypoblast they are at most covered on the external side only, by an exceedingly thin layer of cells. Inasmuch as we know that there are free nuclei imbedded in this plasmodium or yelk hypoblast, is it not possible that they may become the means of developing cells for the walls of the vitelline capillaries as well as blood corpuscles? As remarked some way back, I found that the external epiblastic somatopleural and outer peritoneal layers of the external yelk-sack of the young salmon might be entirely stripped off from the yelk and that they were nowhere adherent to it, and that this exposed the vascular layer covering the yelk. Moreover, the space which lies between the vascular and outer envelopes of the yelk has been derived from the segmentation cavity and becomes abnormally and greatly distended with water when salmon embryos are affected with what is known as "dropsy" amongst fish-culturists. In such cases, too, the space will often contain dead blood corpuscles, after some of the vitelline vessels have been ruptured and injured, which often leads to the partial or complete stoppage of the vitelline and hepatic circulations, which may of course be fatal to the life of the embryo. The hind portion of the outer sack is also sometimes abnormally distended backwards and is finally constricted and sloughed off, while the embryo, which has lost a part of the outer yelk covering in this curious manner, may go on developing normally if the place where the diseased part was broken off has healed promptly. From all of these facts, it may be inferrèd that whatever the significance of a splanchnopleural layer may be it cannot in any case be other than the inner or lower peritoneal part which has been reflected over the yelk and which is traversed by the vitelline blood-vessels. Now in sections through just-hatched salmon, its tenuity is very great and is present only as the thinnest kind of a film over the true yelk hypoblast, but, as already stated, whether it may be certainly identified with the innermost splanchnopleural layer is a question which I cannot certainly answer. On the inner side of the vessels, the blood-cells are seen to lie in immediate contact with the plasmodium or yelk-

hypoblast, and it is to be inferred that blood cells are budded off directly into them, the division of the free nuclei in the subjacent plasmodium probably multiplying and giving rise to these blood corpuscles. In this way it is conceivable that the yelk is gradually broken down, just as we know that by a similar process the yelk of *Alosa*, which has no vitelline circulation, is absorbed. The lumen of the vitelline vessels is also depressed or somewhat flattened upon the yelk surface, and not round as in other parts of the body, and in some cases (*Tylosurus* and *Apeltes*) they have at first the form of exceedingly irregular channels, which are evidently much more deeply excavated into the plasmodium layer at some points than at others. In *Apeltes* the first sign of any vessels is the appearance of a large irregular sinus on one side of the body between it and the yelk in which the blood corpuscles vibrate in unison with the pulsations of the heart, there being as yet no complete open channel or cyclical path for the passage of the blood back to and through the heart. The vessels end blindly at first and are also progressively lengthened, and possibly the rhythmical impulses given to the primitive blood during pulsation helps to open up the channels still farther. Such blind vascular terminations are found on the yelk of a number of species at an early stage of development of the blood system and usually end acutely but finally push towards and open into some pre-existing channel, when they at once become wider. In such blind vascular terminations the blood cells simply oscillate back and forth. In *Tylosurus* the early blood cells may form adherent masses in the great meridional vessel of very uneven caliber, which is the first to be formed and wherein these masses move fitfully or only oscillate with the pulsations of the heart. They soon acquire a reddish tinge, but the fact that they adhere together shows that possibly they are of the nature of confluent white corpuscles or even masses detached from the plasmodium layer which here evidently forms the floor of the vessel, in the act of segmenting and becoming blood corpuscles. This primitive blood of *Tylosurus* is also rich in serum and poor in blood-cells. In *Apeltes* the blood cells are more numerous at a similar stage.

In *Gambusia* the blood-vessels which traverse the yelk, like in *Salmo*, seem more or less deeply imbedded in the yelk-hypoblast layer, and I find it difficult to determine the nature of their outer coverings; internally they seem to lie in immediate contact with the yelk, so that the contained blood-cells in sections of hardened specimens are packed right against and impressed into the plasmodium or yelk hypoblast. The vascular network over the yelk of *Gambusia* is, however, much finer than in *Salmo*, and relatively thicker as seen in sections, but the external covering of the yelk-sack, unlike in the latter species, is not thick and two-layered, but exceedingly thin and formed solely of epiblast on the ventral and lateral portions.

In *Alosa* no cellular elements are distinguished in the yelk-hypoblast; it is a thick homogeneous coating over the yelk, with scattered free

nuclei imbedded in it, and in sections strands of its substance pass inwards to be insinuated between the coarse yelk masses in the interior, which are composed of a different kind of granular protoplasm. The The free nuclei are most abundant in the dorsal and anterior portion of the yelk-hypoblast. No vessels or traces of any are ever found traversing it, and with the approach of the later stages of development it is not clear that the heart maintains its wide communication with the segmentation or body cavity as observed at an earlier stage. The yelk, as absorption proceeds and diminution of its bulk results, assumes a fusiform shape or becomes somewhat like an oat-grain in form. All this while, however, its anterior end continues to lie close to the heart and may even be drawn out into a conical process, directed towards the venous sinus. This conical process consists almost entirely of the yelk-hypoblast or outer rind of the yelk proper, which does not disappear with the collapse of the yelk, but is kept of about the same thickness until the whole of it with its contained granular protoplasm is absorbed. In this collapse we may also note another point of interest; it is that the yelk diminishes behind and below so that its anterior end maintains its close relation to the heart while the posterior end, as it recedes towards the head, uncovers more and more of the under side of the liver behind and above it.

The mode in which the yelk hypoblast is continually kept of the same thickness is very remarkable. While its substance is being removed externally by the gemmation of blood-cells from its surface into the segmentation cavity, as in *Alosa*, or into the vitelline vessels in *Salmo*, its thickness is maintained by the apposition of material to its under or inner surface from the underlying yelk, the internal granular matter of which is slowly transformed into the clearer and more homogeneous plasma of the yelk-hypoblast proper. This transformation goes on until the whole internal yelk mass is thus made transferable to the nascent organism of the young fish, by means of the blood-cell gemmation already spoken of. Yelk absorption is therefore a physiological process of the most far-reaching significance. The yelk itself may be compared to the endosperm of a large seed in which the stored proteinaceous matters are slowly broken down by the agency of an organic ferment and rendered soluble and diffusible through the cellulose walls of the component cells of the infant plant. The analogy does not stop here, however. If we look deeper, it is not improbable that we may hit upon the true significance of another set of phenomena which have not, as far as I am aware, been viewed in the light in which we propose to view them in a succeeding chapter.

The absorption of the yelk of the cod embryo is evidently similar to that of the shad. In Fig. 49 a yelk canal *yc* passes forward to the heart from what is left of the yelk *d*. This canal is evidently similar to the arrangement seen in *Alosa*, where there is an anterior conical process

from the yelk hypoblast; the layer *hy* in our figures is the homologue of the yelk hypoblast in *Alosa*.

In the study of the yelk circulation of *Coregonus albus*, or Lake white-fish, the vitelline vessels in optic section appear to have an inferior as well as outer wall and to be connected together by a thin membrane stretching between them. Can it be that this vascular membrane is continuous with the heart through the thin posterior splanchnopleural pericardiac membrane? It would seem as if this might be the state of affairs in this species, if not in all forms. The fact that the Cuvierian ducts develop in the upper lateral portions of this membrane is greatly in favor of such an interpretation. In *Coregonus* we may also observe that there is in the living embryos a very shallow fluid space between the yelk and the vascular layer between the courses of the vessels. In hardened specimens of salmon embryos sections show the vessels depressed; this I now suspect may be due in part to the compression and shrinkage of the outer yelk-sack under the influence of chromic acid. While we can say positively that the posterior and ventral pericardiac wall does not include or cover more than a small portion of the upper surface of the yelk at the time of hatching in *Alosa*, it is probable that when the yelk is almost absorbed that it may entirely envelop it. It may also be said that a marked acceleration in the development of the vascular splanchnopleural yelk-layer continuous with the venous end of the heart may and does probably occur if we may be guided by the evidence supplied by the investigations of Œllacher on the trout. This view will account for the early development of a yelk vascular system in some forms and its absence in others. It will also explain why it is that in some forms an intercommunication exists between the heart and segmentation cavity while it is absent in others. The remarkable law of acceleration and retardation, which was first distinctly formulated by the eminent palæontologist, Professor Cope, is exemplified on every hand in a study of the development of osseous fishes, and furnishes a clew and key to much that would otherwise be obscure.

The embryo salmon, immediately after hatching, has an arrangement of capillaries which is in the highest degree interesting. The main vessels now consist of a great median dorsal aorta which passes backwards just below the subnotochordal rod to the upturned hinder extremity of the chorda. Here intercommunication between the aorta and caudal vein is established by way of a singular caudal network of capillaries, which, first of all, empty into a sinus-like, non-contractile dilatation before they pour their contents into the caudal vein, which then passes forwards ventrad of the aorta towards the head, dividing into the two posterior cardinals above the intestine. These cardinals then give off capillaries again which pass around the intestine and unite into a subintestinal vein as large in diameter as one of the cardinals. The subintestinal vein then passes forwards over the yelk, and, bending a little to the right, ends under the liver, into which it pours its blood,

again breaking up into smaller vessels in the hepatic tissue, from which the blood again emerges to be conveyed in larger capillaries over the yelk-sack, and which pass outwards, downwards, and forwards, to empty into the great median vitelline vein on the ventral face of the yelk, a little to the left side of the middle line. The anterior and posterior cardinals together with the great vitelline vein empty their blood into the venous sinus, from whence it is passed into the heart, and from thence through the branchial vessels is sent through the carotids and aorta, the latter of which is supplied by the combined currents from the four hinder branchial vessels, which converge and meet in a common aortic trunk below the medulla oblongata. The subclavian artery of the pectoral arises from the vicinity where the branchial vessels unite into the aortic trunk. The origin and course of the submaxillary and cephalic vessels I have not made out. Supraocular and postcerebellar veins pass backwards on the head to empty into the jugulars.

The somatic capillaries are somewhat interesting in respect to their arrangement. They are given off from the aorta and pass outwards on either side through the muscular septa between the muscular somites on the middle line of the side, all of them traversing the common septum which divides the dorso-lateral from the ventro-lateral portions of the muscular plates. While these vessels are of a capillary character in the embryo, they become the segmental arteries and veins of the adult. The course of the blood current in them is not in the same direction in all of them, however; in some it is afferent and in others efferent in direction, so that it would appear that some of the segmental vessels were really venous and others arterial. After reaching the surface the arterial segmental vessels divide dorsally and ventrally into branches which follow the courses of the intermuscular septa to pass inwards at the dorsal and ventral borders to unite with the cardinal or caudal veins. The venous segmental vessels are supplied from two vessels which have exactly the same course as the intersegmental capillaries of the arterial segmental vessels, but the blood-flow is outwards. They bend over the upper and lower edges of the muscle plates, follow the septa, and at the middle line of the side, at the level of the horizontal septum, between the dorso-lateral and ventro-lateral plates, converge into an incurrent segmental vein. These intersegmental veins and arteries do not alternate regularly; there may be two arterial vessels in succession followed by a vein between the next two following segments. The dorso-ventral intersegmental capillary loops convey the blood from the aorta and to the great veins, so that in the case of a true intersegmental vessel it may have either a single or a double origin from the aorta, according as the outgoing vessel passes directly to the surface at the middle of the side or by way of dorsal and ventral arterial loops. The mode in which these vessels are channeled out in the body I have not been able to make out.

In *Coregonus* the vitelline vascular system is not so complex, but,

as in *Salmo*, there is a subintestinal vein, which, unlike the sub-intestinal vein of *Salmo*, is bent upwards just at the hinder extremity of the yelk sack to end in the liver, in which it breaks up into a hepatic plexus to emerge in the form of vitelline capillaries.

In *Gambusia* the subintestinal vein is short or absent. My reason for thinking it absent is the fact that there is no vessel in this form which has the same origin and termination in the liver as in the salmon. What might be regarded as a subintestinal vein is the anterior end of the caudal, which is bent downwards abruptly and traverses the posterior portion of the abdominal cavity obliquely to divide on either hand into a posterior vitelline vessel or vitelline canal on either side of the yelk, which passes forwards to join and pass somewhat beyond the outgoing Cuvierian vessels into which the liver also pours its blood at one side. From these lateral vascular arcs the vitelline capillaries take their origin; they have a generally downward and forward direction.

About the twenty-fifth day after impregnation, and five days after hatching, in the series of cod embryos studied by the writer, there was a complete circulation apparent in the branchial vessels, the aorta, and cardinal veins, but only for a short way back. This primitive circulation did not extend much beyond the extremity of the intestine or abdominal cavity at this stage. In Fig. 40, twenty-two days after impregnation no sign of circulation could be detected. In three days more, however, blood corpuscles began to be more abundant and the vessels could be seen to be slowly and progressively forming from before backwards in the strand of vacuolating mesoblast underneath the notochord. With the progressive lengthening backwards of the aorta and caudal vein, the point of union between them was also pushed backward, but by what histological process was not made out. The point of union between the caudal end of the aorta and the caudal vein is shown at *p*, Fig. 45, representing an embryo ten days after hatching. A subintestinal and lateral venous intestinal trunks were also developed at this stage, which were joined together by short vertical vessels.

24.—Development of the pigment cells of embryo fishes.

In the embryo cod, as in young fishes generally, pigment cells begin to be differentiated just under the epithelial layer of the epiblast at an early period. In the cod they appear as small rounded scattered cells of a slightly darker color than the surrounding tissues about the time of the closure of the blastoderm. From that time forward, however, they become progressively darker and more densely loaded with granules of melanin. They also soon lose their primitively rounded or biscuit like form and become depressed and manifest a tendency to throw out flattened pseudopods or prolongations in all directions. When far advanced in development, as in the later stages, the dark melanin granules do not entirely obscure the nucleus of the pigment-cell which may be noticed in its center as a very refringent body entirely devoid of

pigment granules. The pigment-cells of the body are the first to be developed and are the first to become stellate, as shown in Fig. 32, where those on the tail are still approximately round. Up to the time of hatching they are pretty uniformly scattered over the body and less abundantly on the head, as shown in Fig. 34.

Beyond this stage a marked change in their distribution occurs which cannot be explained without supposing them to possess to a certain extent a power of migration or means of changing their original position beneath the dermal epithelium. They aggregate in unerring regularity in every embryo at about the same places after hatching, as may be seen in Figs. 40, 42, 45, and 49. Two clusters of them are uniformly aggregated on the dorsal and ventral surface of the tail, as shown in Figs. 40 and 45 at *pi*. In the first figure they are less densely aggregated than in the last; this is due to a spreading of the pseudopodal prolongations of the pigmented protoplasm composing them. Some of them in the cod now have, when highly magnified, a striking resemblance to a flower, the corolla of which is represented by the radially arranged and flattened black protoplasmic processes of the cell with the clear nucleus in the dark center. On the head region they remain isolated and even without marked processes, as may be seen upon looking at those represented on the brain and jaws in Fig. 49.

A second and internal layer of pigment cells is developed in the embryo cod. These are confined to the dorsal parietes of the abdominal cavity and seem to underlie the peritoneum. These appear later than those found in the skin, and whether there is any genetic relation between the dermal pigment cells and those of the abdominal cavity would perhaps be hard to say, though it is to be remembered that since we know them to possess migratory powers in other situations, it may not be impossible for the pigment cells of the abdomen to have primarily originated from the same layer as those of the skin. In Fig. 49 they are shown as especially well developed just over the intestine, liver and air-bladder as far forward as the base of the breast fins.

In the young four-spined stickle-back, *Apeltes quadracus*, a second kind of pigment cells are developed, forming a row on the median dorsal line and a row on each side of the body. These are of a dirty yellow color, but they develope precisely like the more numerous black ones which surround them and which give the very dark color to the young of this species, which are as dark as young tadpoles, two or three days after hatching.

The young goldfish (*Carassius*) has only black pigment cells developed after hatching, no sign of the bright red color being apparent in just-hatched embryos known to have been spawned by red-colored parents. The same remark applies to the young of *Idus melanotus*, another cyprinoid, in which the skin of the adult is brilliantly colored with red or orange-red pigment.

To show that light has probably very little to do with inducing the

development of pigment in an embryo fish, we have the very remarkable case of *Gambusia*, in which pigment-cells are developed in the skin, especially on the head, to a remarkable degree, or almost as densely as in the young of *Apeltes*, while the young fish is still inclosed in the ovarian follicle of the mother. The conditions by which it is surrounded in the follicle being especially unfavorable to the accession of light, inclosed as it is within the more or less extensively pigmented walls of the abdomen of the parent, and we are driven to the extremity of supposing that this prenatal pigmentation of the embryos of *Gambusia* is due to the unsuppressed influence of heredity.

In conclusion, it may be of interest to note that the young of *Parephippus*, which in other respects develop almost exactly like the Spanish mackerel during the early stages, soon show a tendency to form a reddish pigment over the abdomen and remains of the yelk-sack, on the third day after hatching. The reddish pigment-cells of this form are often confluent and have long and complex interjoined processes, much flattened, like pigment-cells generally. In the young of the same species an inch in length, the future vertical bands of the adult are already outlined in black. The red pigment seems therefore to have a larval significance, and to be useful probably during an early period of development only.

25.—The law of displacement of the germinative vesicle.

It is well known that in the large-yelked or meroblastic eggs of many vertebrates and invertebrates there is a migration of the nucleus of the egg at a late stage of ovarian development towards the surface before the nascent ovum has left its follicle. It is noteworthy that, on the other hand, it is only the small holoblastic or evenly segmenting ova without a yelk which retain their nucleus nearly in the center to the time and condition of emission from the ovary. Examples of this type are presented to us in the mature ova of mammals, of *Amphioxus*, and many invertebrates. In the egg of the oyster only a slight eccentricity of the nucleus is notable in the mature egg, and we find that its eggs depart but slightly from the holoblastic or even type of segmentation. In *Nassa*, a gasteropod studied by Bobretsky, the segmentation is more unequal, and therefore approximates the meroblastic type more nearly than the egg of *Ostrea*. The observed facts with regard to the displacement of the nucleus or germinative vesicle before impregnation, lead us to enunciate the following general principle: *The nucleus or germinative vesicle is permanently displaced from the center of the ovum in proportion to the amount of food-yelk which is developed, the amount of its eccentricity, or the distance through which it is displaced from the original center of the ovum is governed entirely by the amount of food-yelk which is stored in an egg during its intraovarian growth.* This appears to be a fundamental law of ovular development in general, and one which is far-reaching in its significance in relation to the later phenomena of

cleavage. In fact, it gives us a clew to why it is that there is such a distinction between ova as the evenly and unevenly segmenting or the holoblastic and meroblastic types. It will also be seen that it is probable that the two types pass into each other by insensible gradations, which we find is truly the fact when we come to institute a large series of comparisons between observed types of development. Moreover, the food-yelk has simply a physiological significance; it is merely a store of food, which has been superadded during the intraovarian growth and maturation of the egg, yet the effect of this superadded yelk is to modify the process of segmentation profoundly. That store of deutoplasm which is added to the egg to nourish the embryo and carry it to that condition of development when it can in a measure take care of itself, is also of profound significance in relation to natural selection, by the operation of which it can alone be supposed that yelks were evolved. This all-comprehending Darwinian law is therefore seen to have influenced the mode of segmentation of ova by and through the minor and secondary law of nuclear displacement which has been indicated above.

The degree also to which the nucleus is transported from its primitively central position determines the degree of inequality of the first segmentation. It is now in the highest degree probable that in the formation of the germinal disks of meroblastic ova the process is one and the same throughout the animal kingdom, viz, that its development is accomplished by the migration and concentration of the germinal matter of the egg at its animal pole. We have evidence in superabundance in favor of such a view of the matter, in a great many departments of embryology. There is an evident tendency on the part of the germinal protoplasm of ova to separate itself spontaneously from the food yelk or deutoplasm and aggregate itself either superficially over the whole surface of the ovum, as in the case of centrolecithal, or at one pole mainly, as in meroblastic or telolecithal types. We will find, however, that the distinction between these two forms is primarily less important than might be supposed, for the meroblastic type passes through a distinct centrolecithal stage prior to the development of the germinal disk in *Gadus*, while in other forms the mode of disk development is complicated by a network passing down into and between the deutoplasm masses from the external stratum of germinal protoplasm, as in the ova of Clupeoids and *Leuciscus*. The remarkable centrolecithal segmentation and arrangement of the protoplasm of the eggs of the arthropods is, therefore, found not to be so radically different from the usual type as might at first be supposed. Its arrangement, under slightly different laws of segmentation, is referable to the same fundamental principle governing the dissociation and aggregation of the protoplasm and deutoplasm into separate masses. I would also regard the deutoplasm as almost entirely passive in the process of its absorption during the later stages, for we have seen that it is actually appropriated by a remnant of the original

germinal protoplasm, which takes it up by intussusception and apposition. The coarser granules of the deutoplasm are slowly broken down, as we saw in the case of *Alosa*, and converted into the more homogeneous and much more finely granular and more highly vitalized protoplasm of the yelk hypoblast.

In the very act of the mechanical dissociation of the protoplasm of the egg from its deutoplasm, we have an explanation of why the nuclei are attracted to the former and repelled from the latter. The first is the portion of the egg which is dynamic in character, the portion in which developmental potentiality inheres; the second is in the static condition of what Beale might perhaps call "formed material." This attraction of the nucleus or germinative vesicle for the protoplasm of the egg points to its true nature, and must be of a directive or trophic character, as insisted upon by Rauber; its office, in short, appears to be to direct those phenomena of protoplasmic rearrangement and contractility, and perhaps of metabolism, which transpire during segmentation. The rhythmical metamorphosis of the nuclear bodies into complex "asters" or caryokinetic figures, with granular lines radiating in all directions through the surrounding plasma, like the pseudopods of a heliozoön, would seem to indicate that something of this sort is the function of a part, at least, of the nucleus.

The first segmentation furrow, or that usually described as such, which divides the germinal disk of the Teleostean ovum into two halves, is, according to Hoffmann's investigations, not the first, but, on the contrary, must be considered as the second to be developed in the order of time. His researches have shown that a cleavage spindle is developed, when the germinal disk is finally marked off from the yelk hypoblast, just after impregnation. The axis of this spindle also coincides with the diameter of the egg. We therefore have, in this fact, the final proof of the law of nuclear displacement, which has been pointed out a little way back, and also why it is that there may be a great dissimilarity in the size of the deutoplasmic, as compared with the protoplasmic mass of germinal matter, dependent as this must be upon the amount of food yelk which has been stored in the ovum during its intrafollicular development.

Inasmuch as the yelk of some ova has the form of coarse ovoidal bodies, involved in a matrix of soft plasma, as in those of *Lepidosteus* and *Amia*, for example, an approach is evidently made towards the condition of the stored nutrient materials in the cells of seeds. As in the latter, we may call these bodies, which are said to be composed of *ichthyine* by chemists, *globoids*. Upon making sections of the mature ovarian ova of *Lepidosteus*, I find that the germinative vesicle has left the center of the egg and passed outwards almost into contact with the egg-membrane. Here the nucleus is surrounded by a mass of germinal matter evidently destined to form the germinal pole of the egg. The coarse globoids of the central and lower portions of the egg gradually

grow smaller as they approach the nucleus, around which they form a discoidal mass with the nuclear body imbedded in the center. The globoids of this incipient germinal disk are very small but ovoidal in form like the larger ones of the deutoplasm. They therefore simulate the granules or microsomata of other protoplasm in general. The nucleus still maintains its spherical form in the disk. It may be that in some such way the protoplasm of the germinal disk of the eggs of osseous fishes is developed. We find, in fact, that an opaque granular stage precedes the clear stage of maturity, by which time also the nucleus has migrated from the center and disappeared in the rind of protoplasm which now envelops the deutoplasm; this protoplasmic envelope now constitutes the true hollow egg cell with the nucleus in a very eccentric position imbedded in it or intimately blended with its substance, while the deutoplasm may be looked upon as stored material or added material, in short, rather as the cell contents than as an active part of the cell itself. According to this view it also becomes of interest to note that the position of the oil spheres or drops in fish ova is due to the same cause as that of the deutoplasm or food yelk. They are, in fact, always more or less deeply imbedded in the deutoplasm itself, and not to any extent in the protoplasmic envelope. The fish-egg is, moreover, directly comparable to a fat cell, in which large oil-drops have been formed internally, the presence of which has compelled the nucleus to assume a parietal position at some point in the superficial enveloping protoplasm; just as in the fat cell the nucleus has been repelled from its central position by the encroachment of the stored fat, the nucleus of the Teleostean ovum has been displaced by the encroachment of the stored deutoplasm.

In the true first segmentation we also saw that the protoplasm was differentiated into two parts, viz, a true germ disk capable of segmenting and developing the embryo, and a protoplasmic yelk envelope, the function of which appeared to be entirely that of an appropriative and transformative membrane, histologically a syncytium, concerned mainly in the elaboration of blood from the deutoplasm. The workings of the general law which we have been tracing is evident wherever we meet with meroblastic or centrolecithal ova, and is, as we have seen, of great physiological importance and invariably determines the plane of the true first cleavage and consequently the relative dimensions of the germ disk and yelk. It may be said, however, that the proportional bulk of germ and yelk is probably determined by the higher laws of the struggle for existence. It is also true that the bulk of the yelk has not the slightest value in classification, as great variations occur in respect to size within the limits of the same family of fishes. Again, it is singular that the eggs of some amphibians should approach much more nearly than those of the fishes the holoblastic or evenly segmenting type, while the much smaller ova of many of the latter should present us with an extreme form of the meroblastic type. The only explanation

applicable to these cases seems to lie in the physiological relation pointed out as subsisting between the germinal and nutritive matter of the egg, which determines the plane of the first cleavage, but this does not dispose of the question why one form with a much smaller egg should be supplied with a much smaller amount of germinal matter than another with a much larger egg. The consequences of the comparison just instituted between the ova of the frog and fish do not stop here, however, for we actually find that the amount of germinal and nutritive matter in proportion to each other is not the same even in different genera and species of fishes. I now call to mind illustrations of this from amongst the Salmonoids. In *Osmerus* the germ is much larger in proportion to the yelk than in *Salmo*. Of two forms belonging to different families, *Alosa* has a relatively much larger germ than *Tylosurus*, in the latter of which the germinal disk is reduced to the extreme of relative diminutiveness amongst the fish ova which I have studied.

The remarkable phenomena which have been discussed in the preceding paragraphs are due altogether to the inherent motility of the protoplasm of the germ and nucleus. What the nature of the force is which impels the protoplasm of the fish ovum to migrate towards the germinal pole or to aggregate into a germ at all we cannot say. While it exhibits actual contractility and a self-moving power resident in and manifested by its own substance, science is not yet ready to assert that it knows anything of its efficient cause. This is a phenomenon as inscrutable in its essential nature as the movements of the living amœba. The movements of the protoplasm of the egg of the fish in the act of forming the germinal disk only resemble to a certain extent those of the amœba; there is no exact parallelism. The amœba, in the active stage, moves about continually in its own peculiar way like any other perfect animal; practically, the protoplasm layer of the fish ovum stops moving in a distinctly amœbal manner after it has aggregated itself into the germinal disk. In these respects the perfect organism of the amœba differs from the germinal matter of the fish no less than in its want of any power of segmentation and metamorphosis into a determinate species of fish embryo. The current ridiculous and unscientific statement that the germs of animals may be likened to an amœba has no foundation in observed fact. From their earliest incipiency fish ova differ radically from an amœba in appearance, and would not be mistaken for one by the merest tyro.

The nucleus of the amœba after the ingestion of food is usually displaced to a marked extent from the central position. This eccentric position of the nucleus of the amœboid *Protoplasta* seems to be dependent upon essentially the same cause as the displacement of the nucleus in the meroblastic egg, viz, in consequence of the absorption of materials by the endosarc, which require to be raised to the condition of the living protoplasm of the rest of the animal by metabolic processes. The

ingested food-materials taken up voluntarily by the amœba are analogous to the deutoplasm stored in the protoplasmic envelope of the meroblastic egg, and carried to it by the blood vascular network which traverses the ovarian follicles; with this difference again, that whereas the transformation of ingested material by the amœba is probably carried on by the help of organic ferments developed during digestion, the addition of new material to the growing egg is probably effected by a cumulative process without the help of a ferment, the stored proteids undergoing an actual retrogressive metamorphosis into non-contractile globoids, or granular, globular, or ovoidal vitelline bodies in a condition of stasis or quiescence.

It also appears to be true in general that, whenever the layers of cells comprising the whole or part of the yelk begin to segment, those of them containing yelk material or granules have the nucleus more or less extensively displaced from its central position, which is in conformity with the general principle stated. For convenience we may name those forms of cells and ova which do not have the nucleus permanently and notably displaced, as homogeneous or *homoplastic*, and those which exhibit marked permanent nuclear displacement as heterogeneous in composition, or as being *heteroplastic.*

This scheme does not exclude such types of cells as those of the notochord or the yelk-sack of a fish egg with its contained oil drops. We find, indeed, that a large oil sphere may be the last part of the yelk to be gradually broken down during yelk absorption, as in *Cybium.* The reasons for regarding the yelk as a cell have already been stated, and it will be needless to vindicate the claim of the chorda cells with their large fluid cavities to that designation. The true first cleavage of the Teleostean egg occurs when the germ disk is finally differentiated at the time the first segmentation nucleus divides, leaving one half of the latter in the plasmodium or yelk hypoblast, the other in the germ disk. At this stage, therefore, the germ is a cell and the plasmodium envelope covering the yelk another. The germ cell is the active animal cell; the lower or yelk-containing cell is the passive and negative one, the contents of which are mostly broken down during development by the metabolic agency of the plasmodium envelope.

A set of phenomena are, however, to be considered in this connection which must qualify the preceding general statements. I have been careful to say that the nucleus of the meroblastic egg is *permanently displaced* when maturation is complete; that is, even after the extrusion of the polar cells. In holoblastic ova there is a marked recession of the remains of the nucleus concerned in the first segmentation towards the center of the egg after the extrusion of the polar cells; in fact after being shoved to the periphery to form the amphiasters and polar cells its remains return to a more nearly central position as the first segmentation nucleus than that occupied by the germinative vesicle at the time the egg was freed from the ovary. This is also a fundamental distinction be-

tween the meroblastic and the holoblastic types of eggs. The return of the segmentation nucleus towards the center of the egg is apparently prevented by the presence of yelk or deutoplasm in the egg. The second or subsidiary principle qualifying the first in that *the degree of recession of the segmentation nucleus towards the center of the egg is determined by the amount of food yelk which is present in its center or at its vegetative pole.*

We must not, however, forget to mention that in the meroblastic eggs of the frog, and *Clepsine*, according to Whitman, the first segmentation nucleus may return to the center of the egg after impregnation and segment twice, forming four nearly equal cells, before the four new nuclei are finally repelled to the animal pole to establish a meroblastic form of segmentation. These appear to be cases in which the final displacement of the nuclei has been retarded. The principle involved is the same, however.

26.—ON SOME OF THE PHENOMENA OF SEGMENTATION AND GROWTH.

Recently the study of the processes of segmentation has been pursued very successfully by a large number of investigators upon a considerable number of forms. One of the most recent papers on the subject is by Prof. A. Rauber,* who has taken special pains to investigate the successive development of the segmentation furrows and their relations of direction to each other and to the axis of the nucleus in the act of division, as well as the direction of the cleavage planes of segmenting cells in relation to the growth in extent of a flat membrane or other structure. He also considers the phenomena of contractility or movement of the protoplasm during segmentation and has arrived at what appear to the writer to be some very important conclusions respecting what may be regarded as evidence of its structure and the relations which this bears to processes of growth and metabolism or waste and repair. Without pretending to review Rauber's important contribution to the subject of the morphology of protoplasm, if we may so speak, the writer has for a considerable time past been approaching somewhat similar conclusions regarding the nature of the physical substratum of vital phenomena. Many of our most able investigators have been striving to represent it in an altogether too simple and homogeneous form, until the idea is widely prevalent amongst otherwise well-informed persons that there is really some such thing as an homogeneous primordial living jelly out of which all living beings are formed. It is stated by some to be a colloid, like gelatin or gum, but if we study it narrowly we find that it differs physically in a good many respects from these substances, one of the most striking of which is, that unlike the not-living colloids it will not mix in any given proportion in the living

* *Neue Grundlegungen zur Kentniss der Zelle. Morphologisches Jahrbuch, VIII,* pp. 233–338, pls. XI–XIV. Leipzig, 1882.

state with water as they do. That it has colloidal properties of a kind which are conditioned by its living state no one would perhaps deny, but to treat living matter with the same terms and with the same implications as not-living diffusible substances is manifestly an abuse of terms. Nor does the implication stop here, for if we look into the processes of secretion in living bodies, there is apparently a tendency on the part of the living membranes to act somewhat like dead ones, yet it will require little reflection to satisfy the most ordinary mind that there is not only a difference of degree, but of kind, when the two are compared. The not-living membrane depends upon purely physical principles for its workings, while the living membrane is an appáratus in the true sense of the word, often comprised of many parts with diverse functions, such as columnar or ciliated pavement epithelium, with connective fibers, muscle, nerves, and vessels composed of cellular units, each of which may have a specific share in the processes of transudation carried on in follicles or cavities of glands or other organs. It is true the differentiation of these complex structures disappears as we descend in the scale of life, yet it is also true that we have almost as constantly developed in the lowest types, as well as in the highest, certain bodies in the interior of cells, which, with a few unimportant exceptions, seem to have some sort of a vital relation to the plasma in which they are imbedded; we refer to nuclei. These bodies, if we may place any reliance upon what is manifested during embryonic development, seem to be very intimately, and even physiologically, related to the phenomena of cleavage during development, and not improbably with nutrition and the metabolic processes occurring in the interior of the cell. If something of the sort is not their function, the apparently more fluid contents, and even trabecular network sometimes found in their interiors, are without significance. Leaving out of the question any radial, or, more exactly, any heliozoöidal* arrangement of the granular matter around the nucleus as argued by Rauber, it is at least evident that the process of impregnation is almost always, if not invariably, accompanied by nuclear metamorphosis and the development of asters, or single and double heliozoöidal figures, imbedded in the protoplasm of the egg. These phenomena seem to be more or less constant accompaniments of later growth, of which impregnation seems to be in reality only a particular phase, bridging the vital continuity between sexual parents and their offspring. The phenomena of indirect cell-division or that accompanied by caryokinesis or the development of cleavage spindles or a double heliozoöidal arrangement of the granules of the medullary or inner cell substance, which may extend even to the peripheral cell surface or wall, probably have a similar significance and seem intimately bound up with the primary phenomena of growth or segmentation, of which they are a pretty constant attendant in the early stages of most forms which have been

*A word which has suggested itself from the resemblance of some nuclear figures to a Heliozoön with its radiating pseudopods.

closely enough investigated. In fishes, these caryokinetic or nuclear figures are found by me in the segmenting blastodermic cells at a late stage, or after the blastoderm has already covered half of the yelk sphere. Similar facts are recorded of the germinal area of the blastoderm of higher types by Rauber.

Hardly any one would attempt to dispute the ground taken by Rauber that cell-division is the result of growth, addition, or further differentiation of plasma, and not the reverse, else we should very soon be brought to the absurd position of assuming that cell-division might go on indefinitely without the addition of new matter, which we know is not the case. In the preceding section on nuclear displacement, which is very commonly manifested, so commonly, indeed, that perhaps relatively very few perfectly holoblastic or evenly segmenting ova are known, we have an extensive piece of evidence in favor of the doctrine that growth must precede segmentation. Just exactly how the passive deutoplasma is broken down and raised to the grade of protoplasm we do not know in detail in many cases, but we do know enough of the process in others at least to infer what may be its general type or mode in all. In general terms, it may be stated that the deutoplasm or yelk is more or less closely invested or inclosed by the germinal protoplasm, the function of which is clearly appropriative either by direct contact or by the agency of fluid ferments acting by means of what Foster would call "vascular bonds," or even through mere intercellular or segmentation cavities.

Let us look and see if we have any evidence for this theory of growth in the later phenomena of maturation of the fish ovum. We know that in the later stages of egg-development the protoplasm is to a great extent superficial or peripheral in position. In the process of germformation at one pole we in reality behold neither more nor less than a growth, upbuilding, or aggregation of the protoplasm from the surface of the vitellus, or even from its interior, to form a germ-cell which will be segmented off at the time of the first true cleavage. That cleavage will, however, leave behind a modicum of germinal protoplasm surrounding or even insinuated into the yelk in strands, which will be the efficient cause of the transformation of what remains of the deutoplasm into a form fitted to enter into the further development of the embryo as a plasmine-like substance or as veritable nucleated protroplasmic bodies. These later phenomena, after development has progressed to a definite stage, are every whit as much to be considered phenomena of growth as if the embryo were already feeding. The incorporation of a food yelk seems to a certain extent almost like the process of digestion in an amœba, with only this difference, that the deutoplasm cannot properly be called dead matter, like the food of the amœba, but protoplasm in an inert or quiescent state. The parallel does not stop here, however, for we actually have fluid spaces formed in many embryos around or partially around the yelk, or in closed cavities surrounded by cells, just

as in protozoa and amœboid forms generally the food particles are taken into spherical cavities and surrounded with a watery fluid to which ferments are probably added during digestion from the surrounding plasma, so as to dissolve and incorporate by diffusion and intussusception that which was not into that which so becomes part of the amœba. The presence of clots of amorphous matter in the cavities of fish embryos when sections are prepared has often struck me as evidence of something of the sort described above. These may, however, be artificial products, and the effect of the extractive and solvent action of chromic acid and the precipitating action of alcohol.

Not less interesting than the phenomena just described are some of the irregularities of cleavage. These irregularities were formerly not much noticed, or if noticed, investigators were not in a position to assign to them their true significance. It is probably true that most embryos will be found to vary more or less notably, if the segmentation of large numbers of ova be carefully studied and compared. We know, for example, that two well-marked types of segmentation are found to obtain in *Ostrea virginica*, as shown by Brooks. Those of other types also are known to vary, often greatly, in the details of the relations of the segmentation furrows, especially at their points of meeting—that is, where new furrows run towards and join preceding ones. From the investigations of Rauber, we may infer that in some forms this irregularity is very marked—so much so, that outline diagrams of the cleavage furrows of, say, the morula stage of any two ova of the same species would nowhere exactly coincide if superimposed. This irregularity is found to obtain extensively in meroblastic ova, and is, perhaps, almost constant in them, so that we discover that a tendency toward individual variation exists in part at the very beginning of development, without, however, interfering with a well-marked or characteristic plan of development in the case of each form.

The irregularities in the cleavage of the germinal disk of fishes become evident at a very early stage, but most conspicuously after the germ has been divided into four cells, as shown in Figs. 33*a*, 33*b*, and 39. Slight differences in size may also be noticed at the time the germ is divided into two segments, as in Fig. 44. In Fig. 33*b*, giving an outline representation of the germ of the shad's egg, the whole has an oblong, subquadrate form, as seen from above. The first transverse furrow *ii*, *a*, *ii*, is bent obtusely at the two points where the furrows of the second cleavage *i*, *i*, meet it. This is actually an effect of the second segmentation, because we do not find a short section *a* of the first cleavage furrow having a course different from that of the outer limbs *ii ii* prior to the second cleavage. At the time the first segmentation furrow is fully formed in fish ova, generally, it divides the germ disk straight across, as in Figs. 9, 35, 37, and 44. The inequalities observable in the arrangement of the furrows seem to be mainly due to the displacement of the cleavage planes, or, perhaps, more properly, to a slight angular shifting

of the nuclear plates developed during the second cleavage. Rauber seems to lay stress upon a more or less extensive swinging round of the axis of the cleavage spindles, after the second and especially the third series of cleavages begin in the frog's ovum, by which he very clearly and beautifully accounts for the variations of segmentation in that form. This he thinks may be due to what he calls *segmental attraction* between blastomere and blastomere. The contractions of the protoplasm of the blastomeres during segmentation, by which certain ones are displaced, repelled or attracted by others, is also considered. He likewise thinks that the poles of nuclear spindles or new centers of adjacent cells may have an attraction for each other. The cleavage planes or the furrows between homologous cells of similar ova may differ from one another in direction as much as 90°; ordinarily the variation is much less, for a variation of 3° to 5° would be sufficient to produce the most striking variations.

For my own part I would be inclined to ascribe the dislocation of the cleavage planes in such germs as are shown in Figs. 33*a* and *b* mainly to the contractions of the protoplasmic mass of the blastomeres during segmentation. It is quite certain that at the beginning of cleavage the germs of fish ova are discoidal, and that during the development of the first cleavage furrow the disk elongates remarkably in a direction at right angles to the first furrow, as may be seen in Fig. 9. Not only does this occur, but the two new segments are also usually produced on the upper surface into pretty acute obconical points when viewed from the side. This occurs when the cleavage furrow is developing, and implies a heaping up of the protoplasm of the blastomere by its own powers of movement. Sometimes after the two blastomeres have assumed the conical form spoken of they slowly subside, in consequence of which they again assume a depressed form with the cleavage furrow very much less distinct. All of these phenomena signify an active movement of the substance of the blastomeres, in which the nuclear spindles undoubtedly have an important office to perform. That contractions of the outer substance of the blastomeres do occur we have evidence in the development of the superficial wrinkles in the cleavage furrows shown in Figs. 33*a*, 35, and 44.

The effects of the dislocation of the cleavage furrows by the contractility, or perhaps reciprocal attractions and repulsions of the blastomeres, is further shown when we glance at Figs. 12 and 13. The heavy dotted lines of Fig. 33*b* also show how the third series of cleavage furrows may be displaced so as not to meet each other exactly where they join those of the second *i*, *i*. This displacement of the cleavage furrows seems to be the rule rather than the exception in almost all forms of development. This disjointing or dislocation of furrows, too, does not seem to arise from mutual pressure during the early stages so much as from actual contractions, as already pointed out, but the pressure of the cells upon each other, which takes the place of the contractions after

the latter have subsided, tends to compel them to maintain their irregular forms and thus afford the starting points for still further irregularities of cleavage.

After a while also the series of successive segmentations are no longer synchronous—that is, after the third or fourth series of cleavage furrows have developed, it will be found that if sections of germinal disks are examined there will be evidence of division in some cells and not in others. In some cells caryokinetic or nuclear firgues are present; in others they are wanting. Not only is this true, but where the disk contains upwards of 1,000 cells the nuclear figures of different cells are also found in various stages of metamorphosis, while a much larger number are quiescent or resting. This tendency to heterochronous division of the nuclei of the germ is another very striking illustration of the law of acceleration and retardation of development.

The acceleration and retardation of the metamorphosis of the nuclei again probably depends upon the nutritive processes and metabolism occurring reciprocally between the component cells of the disk, and by way of intercellular spaces as well as the segmentation cavity. It is certain that respiratory processes go on during segmentation, and it may not be impossible for the segmentation cavity with its thin roof to be partially respiratory in the ovum of osseous fishes. It is also quite certain that Newport and Ransom were justified in regarding the water space around the vitellus and germ or the cavity between the ovum proper and the egg-membrane as respiratory in function. One of these authorities, I do not recall which, first named this cavity the *breathing chamber*. It is developed, as already described, at the time of fertilization. There can also be little doubt that respiration goes on in young fishes, which are without a circulation at the time of hatching. If, as we have seen, there is evidence of the existence of respiratory processes in embryos long before any spontaneous movement of the body is visible, it is fair to infer that such a process can and probably does influence the rate of segmentation.

The final proof, however, that respiration occurs in fish embryos is that it is positively necessary in the construction of hatching apparatus to have it so arranged as to constantly change the water upon the eggs. This is done simply to supply the developing embryos with fresh, oxygenated water. Still another proof that respiration must occur in fish embryos before a circulation is developed is the fact that young shad move by contorting the tail some time before they leave the egg-membrane. The muscular contractions of the lateral muscular plates so manifested must be accompanied by the evolution of carbonic acid, which must be carried off and replaced by oxygen. This can manifestly not be accomplished more directly than by way of the water in the so-called breathing chamber surrounding the embryo fish.

It will be noticed upon comparing the outline of the disk represented by Fig. 10 with Fig. 33, that the latter is more nearly circular than the former. The latter has passed farther into the resting stage,

and is therefore more depressed. This elevation and depression of the upper surface of blastomeres in the course of segmentation is often a very marked feature, and gives rise to the most singular superficial irregularity of the whole disk up to the time of the completion of the morula stage of development. These changes are doubtless due to internal movements of the substance of the blastomeres, dependent upon an internal radial contractile structure.

The radial and reticulated structure of protoplasm is to Rauber of the most profound significance in relation to the phenomena of growth and development. His conclusions are here, in part, reproduced :

"1. Radial and trabecular structures of protoplasm are not essentially distinct but are manifestations of the same principle, in that the latter is developed as a result of vacuolization, the former in the direction of readiest division (*spaltbarkeit*).

"2. The radial and trabecular structure of animal as well as vegetable protoplasm is a factor with which every investigation into the history of the growth of an animal or a vegetable body has to do; such structure is vitally related to the beginning of development.

"3. The radial and trabecular arrangement of protoplasm grows both by the addition of new material from without, at its peripheral ends, as well as by the incorporation of such material within the preexisting substance, or both by apposition and intussusception. The protoplasmic streaming necessary for this purpose is facilitated by the interradial passages and the corresponding series of spaces in vacuolate protoplasm."

Of the nucleus he says:

"The finer phenomena of caryokinesis display to us, in a manner such as does scarcely any other process, working nature at her loom. Groups of granules are the raw material which she next arranges in rows of threads. In astonishment we observe the most manifold looping and splitting of the granular threads and the completion of the most delicate chromatin structures." * * * "The structure of the nucleus is variable only during the periods of division. In the condition of rest its structure * * * is monotonous.

"The function of the nucleus can only be such an one as is entirely independent of the differentiation of protoplasm [in different species of living forms], such an one, indeed, as is needed by the most diverse protoplasmic structures. This function can only be trophic. * * *

"Whether this trophic or directive function relates to the metabolic processes, to the formation of centers, or to the regulation of diffusion-streams of protoplasm, must remain undecided, as much as the probabilities are in favor of the latter.

"The essential nature of the structure of the nucleus is difficult to make out; the fundamental form seems to be a radial one, and in such cases may usually be referred to a radial structure, which is not directly manifest externally.

"The nucleus is neither inevitably present in the cell nor yet in protoplasm. Plasmodium on the one hand, and enuclear protoplasm on the other, prove this.

"The surface growth in extent of cellular membranes is conditioned as a rule by two cleavage planes of the cells, perpendicular or at right angles to each other. Attending growth in thickness, as in the epidermis, for example, there is, besides the above, a cleavage plane of the cells parallel to the surface."

The laws of growth and cleavage, which are touched upon in the foregoing extracts, are to some extent a realization of what must have coursed through the mind of almost every student who has busied himself with embryological investigations, or who has watched the recent advances of histology without himself taking an active part in the work. For my own part I believe that we have arrived at a new era in embryological and physiological research. We shall hereafter not only be obliged to figure and study the changes of external form which transpire during development, and the contours of the cells which are concerned in bringing this about in an embryo, but also the phenomena manifested and the changes suffered by the whole contents of the individual cells in the process of embryonic evolution. Here is where anatomy and physiology converge; and upon a comparative embryology as exhaustive in its methods and results as that here contemplated, will it alone be possible to found a comparative physiology equally exhaustive, but infinitely more valuable in its practical application to the needs of every-day life than the physiology of the present. The masterly monographs of Strasburger, Flemming, Fol, the Hertwigs, Whitman, Leidy, and Mark, besides many others, have brought us face to face with a series of facts and phenomena, the significance of which has hardly yet been fully appreciated.

27.—The gastrula and cœloma of teleosts.

The epibolic growth of the blastoderm over the yelk of the osseous fish ovum, as in other meroblastic ova, has given rise to not a little discussion amongst embryologists as to the true nature of its gastrula stage. As Whitman* has pointed out, there is a fundamental similarity in the mode of formation of the neurula in embryos of *Clepsine*, the frog, sturgeon, salmon, chick, and saw-fish. The concrescence of the rim of the blastoderm to form the neurula seems in reality to be the key to the interpretation of the development of the gastrula of the embryos of bony fishes and some other meroblastic types, as well as the development of the cœloma and lateral musculature of the body.

In order to make it easier to understand the gastrula of *Teleostei*, a series of diagrammatic and semidiagrammatic figures are introduced here.

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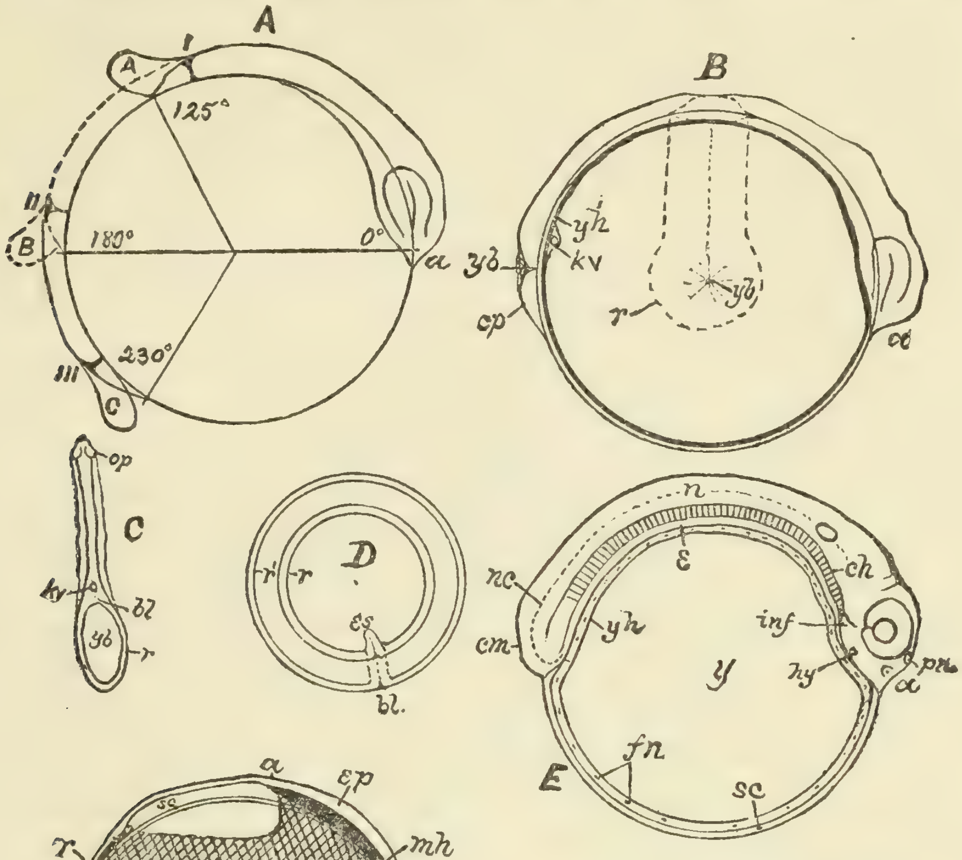
*Embryology of Clepsine, pp. 86–95.

Fig. E, in longitudinal vertical section, represents, for instance, the relations of the neurula *n* and the mesenteron *e*, showing them to be continuous by way of the solid caudal mass *cm*, in such forms as *Alosa* and



Gadus. The dotted line *nc* can be regarded as indicating an open neural canal only at the middle and anterior end of the body of the embryo; nevertheless, the hinder end of the neurula, with the further growth of the tail, actually acquires a lumen, as in Fig. K, but by this time the tail, having grown out some distance, the continuity between the hind gut *e* and caudal mass has been torn asunder, and all that is left to mark their original continuity is a strand of cells *st*, shown in Figs. I and K. This strand of cells was, however, only in part continuous with the gut,

as a portion, perhaps the most of it, is concerned in the development of the subnotochordal vascular tract of the tail. In Fig. I, which is a section through the caudal knob *cm* of an embryo of the same age as that shown partly in K, the muscle plates *mp* on either side of the notochord are found to be continuous with the caudal mass and to embrace between them the swollen, undifferentiated, caudal end of the chorda *ch*, which is somewhat quadrate in section at this time. The hind gut when finally formed as the end of the tail grows away from it, is perceptibly swollen and ends blindly. Dorsally, between the muscle plates, the caudal end of the neurula *n* is quite distinct in sections a little forward of the tip of the outgrowing tail, as shown in Fig. I. It is solid, however, like in the cross-section from the body of a somewhat younger embryo shown in Fig. H. The caudal end of the neurula cannot, however, be traced over the end of the tail at this stage, but ends in the same apical mass of undifferentiated cells as the muscle plates, chorda and postanal strand of cells. The only differentiation of layers at the tip of the caudal knob, in fact, is the skin or epiblastic stratum which covers it.

In order to understand in part the means by which this arrangement of parts is established, we will be obliged to look closely into the manner in which the blastoderm grows over and incloses the yelk. The large size of the latter necessitates such a spreading of the blastoderm, because up to the time that the tail buds out, the yelk diminishes but slightly in volume and does not exhibit any signs of segmentation like the deutoplasmic pole of the frog's ovum. In Fig. D a blastoderm is shown in outline at two consecutive stages of growth, in order to illustrate the fact that as the rim *r* is pushed out to the position *r'* the embryonic shield *es* is lengthened towards *bl* by what would appear to be a concrescence of the rim *r* in a line with the primitive groove. This progressive fusion of the blastodermic rim along the neural axis lengthens the embryo posteriorly. While this appears to be the fact, it is not to be forgotten that, inasmuch as the embryonic cells have certain powers of movement or translation conferred upon them in virtue of a power of more rapid growth in one direction than another, which is again dependent upon the operation of certain hereditary and fixed laws of cleavage, all of which is to be considered, no less than the histological forces which make the concrescence spoken of possible. It is at first hard to understand in what manner the whole of the rim of the blastoderm is incorporated into the body of the embryo fish, but of this we have such overwhelming proof in observed fact that it will be unnecessary to appeal to other evidence. His and Rauber, who were the first to clearly describe this process of concrescence or precession of the rim of the blastoderm, have been criticised by Balfour (Comp. Embryol. II, p. 254). From what the latter remarks it is evident that he never witnessed the closure of the blastodermic rim at the vegetative or caudal pole of the living Teleostean ovum, in some of the rapidly developing forms of which it may actually be seen in the process of transformation

into the caudal plate *cp*, Fig. B, which is wholly converted into the caudal mass *cm* of Fig. E. To urge the history of the closure of the blastoderm in Elasmobranchs as evidence against the process as it occurs in *Teleostei* is unfair, because a considerable part of the blastodermic rim in the embryos of cartilaginous fishes has evidently nothing to do with the development of the body of the embryo, but closes after the latter has been elevated above the yelk upon a stalk.

An actual crater-like depression *yb*, Fig. B, with a fine canal ending upon the yelk, is seen at the time of closure of the blastoderm in *Teleostei*. Viewed from above, as in the dotted outline in B, *yb* is seen to have radiating wrinkles extending out over the concrescing rim *r*. This yelk blastopore so formed is not homologous with the similar pore or cleft in the frog's ovum, because it cannot be shown to have anything more than an indirect connection with the intestine in the embryo fish. This is illustrated in Fig. C, showing an embryo of *Tylosurus* in outline, unrolled from the yelk, with the oval blastodermic rim *r* attached. The latter is concrescing; its contents are flowing together, as it were, where its two limbs join the hind end of the body at *bl*. The opening *yb* is the yelk blastopore, and is distinct from the place where the actual concrescence is occurring viz, at *bl*. In fact, while there is no actual opening into the neural or neurenteric canal at *bl*, neither existing at this stage of development, only the extreme anterior part of the yelk blastopore coincides ultimately with that of the blastopore of the frog, but only momentarily, in that the lumen of both intestine and neurula, contrary to what obtains with the frog's embryo, are wanting at this stage. The sides of the primitive groove coalesce so quickly in *Teleostei*—if, indeed, it can be said that there is such a groove in those forms as we know it in the frog—that evidence of its presence even is evanescent, or it is at most very feebly developed. In the frog the margins of the groove are free, and the neural furrow in the medullary plate is most conspicuous even at the time the blastopore closes, but the latter marks approximately the position of the permanent anus. In *Teleostei* there is no such relation between the yelk blastopore and the vent, which arises in them on the ventral side of the caudal end of the embryo, as shown in Fig. K. An exact comparison of the parts of the frog's ovum with those of the osseous fish is not possible, as Ziegler has endeavored to show; his failure to make out the true state of the case was his want of the appreciation of the true nature of the yelk. In fact, the continuity of the epiblast with the mesenteron, as in the embryo frog, is broken in the embryo fish by the time the yelk blastopore has closed and the caudal plate has formed.

The frog's ovum undergoes total but unequal segmentation; the fish ovum, on the other hand, undergoes equal segmentation of its germ; partial segmentation, as regards its whole mass, while the final segmentation—gemmation—of the yelk substance as leucocytes into the segmentation cavity or blood vessels is carried on after the embryo is far

developed and the heart and vitelline vessels have been formed. There is also present around the yelk of fish embryos an homogeneous envelope, *yh*, Fig. E, containing free nuclei, which is not present in the frog's ovum, nor has it any exact homologue in the latter, because it incloses a large mass of deutoplasmic matter often optically and physiologically different in character from the protoplasm of the germ or the envelope itself.

Van Bambeke and E. Van Beneden, who first described some of the most important phenomena presented by what I have called the *yelk-hypoblast*, named it the intermediary layer. In consequence of the presence of a large amount of deutoplasm in the yelk of the fish ovum, yelk-segmentation has been retarded, in fact has been wholly interrupted, so that nuclear multiplication alone, unattended by actual segmentation, occurs in the yelk envelope *yh*, shown in Figs. B and G. The distribution in it of the free nuclei *fn* is shown in Fig. E.

In the frog the liver develops as a ventral diverticulum of the fore part of the mesenteron, which grows into and at once appropriates a part of the segmented yelk; the latter in fact becomes fused with and forms the exceedingly thick ventral wall of the mesenteron. In the embryo fish this fusion of the yelk mass with the mesenteron or primitive gut never takes place; the liver arises as an independent diverticulum or thickening of the ventral wall of the mesenteron. There is no evidence of continuity between the intestine and yelk of the osseous fish at any stage of development. The appropriation of the yelk by the budding of leucocytes from the yelk hypoblast is effected in some types by direct gemmation into the segmentation cavity, from which the white blood-cells are sucked up by the heart (*Alosa*, *Pomolobus*), or where the pericardiac septum between the heart chamber and body cavity is so accelerated in development as to extend over the yelk as a veil in which the vitelline vessels are developed (*Salmo*) and which are concerned in breaking down the yelk. In the first case the body and segmentation cavities remain connected; in the latter they are soon separated by the development of the vascular veil which grows over and around the vitellus. In all forms of osseous fishes at an early stage the two seem to be continuous. This is shown in the cross-section of the body of a young fish, younger than E, in Fig. H, where the epiblast *ep* and *sep* and the hypoblast *hy* include the muscle and splanchnopleural plate which ends bluntly at *mp*, and to the right of which the segmentation cavity extends, so that in the event of the splitting of *mp* to form the splanchnopleure and muscle plate proper there would be a continuity established between the two; none of the lower layers in fact extend far out on either side of the body between the epiblast and yelk hypoblast. That this view is the true one is proven by the mode in which *Amphioxus* develops its muscle plates as outgrowths into the blastocœl or segmentation cavity of the blastula after the invagination and development of the gastrula, as seen in the cross-section J of an embryo of *Amphioxus*, modified

from Kowalewsky. In fact there is abundant evidence of the truth of the cœloma theory, proposed by the Hertwigs, presented in the mode of development of the muscle plates of *Teleostei*, as lateral outgrowths of the lower layer before the differentiation of the mesoblast from the hypoblast by delamination, as indicated in Fig. H. Ziegler has in fact reached the conclusion that the chorda is of hypoblastic origin, so that embryologists are almost unanimous in regard to the origin of the primiitive axis of the body of the chordata. Such an origin is indicated in the cod by the position of the caudal end of the chorda below the level of the upper half of the thickness of the caudal end of the body of the embryo shown in Fig. 31.

The evidence favoring the marginal ingrowth of the lower layer is to me not as strong as that in favor of delamination. My reasons for this opinion may be stated somewhat more clearly by referring to Figs. 14 and G. In the first, and in both optical and actual sections of a similar stage in other forms, the lenticular germ is shown to be composed of a mass of equal sized cells; in fact a morula condition is developed and no differentiation of layers is perceptible except the single outermost and epithelial stratum of the epiblast. In flattening and spreading there is not enough lateral movement to account for the formation of the wide rim in Figs. 15 and 16, by an infolding of the edge of the disk as it spreads so as to bend the separate lower layer inwards all round the margin. In fact, the segmentation cavity is at first smaller and deeper in proportion to its width than shown in Fig. 15, and the marginal infolding, as it might appear, does not continue with the spreading of the disk, but afterwards takes place only at one point, viz, where the rim is continued into the sides of the embryo. The weight of the evidence is therefore in favor of delamination as the means by which the primary diploblastic condition of the germ is developed and not by gastrulation. The first diploblastic phase of the germ of the fish egg is therefore apparently a planula, and neither its upper nor its lower layers are but one cell deep, but consist in both cases of three or more rows of cells, which can scarcely be said to be arranged in regular layers except those which limit the upper and lower surfaces of two the primary ones.

In Fig. G the upper or epiblastic stratum in vertical section is left white, while the lower combining the mesoblast and hypoblast is shown black in section with its superficial extent in the blastoderm indicated by the hatched lines. The embryonic axis of this blastoderm is cut through from *a* to *bl*. At first one would suppose that there was clear evidence of invagination from behind forwards from the point *bl* in the earlier stages, but, as it has already been remarked, this does probably not begin much before the stage represented in figure G has been attained, and then by the peculiar mode of concrescence previously described.

With the growth of the blastoderm over the yelk the lower layer of the rim *r* does not increase in width, as required by the invagination

theory, but tends rather to become narrower vertically as it advances over the yelk globe toward the level of the line 2, Fig. G, while it is gradually constricted in diameter as it grows past the level of lines 3 and 4, beyond which it closes at *x*. In ova with a very large yelk, like those of the salmon and silver-gar, the blastoderm does not close at a point opposite to that where the germ was developed. This has given rise to some dispute amongst embryologists, a disagreement which may be explained by the diagrams A and G. If we suppose A to represent a very large yelked osseous fish ovum, with *a* as its germinal pole, the body of the embryo will grow, say, to the point A, the blastopore closing at I. The rim will then cease to advance at the tail of the embryo or at the point *x* in Fig. G, when, as shown in the latter, the portion of the rim on the opposite side of the egg will have to advance faster from the point II onward towards III, IV and V, closing at *x* instead of *x'*. When the egg is a medium sized one, like that of *Alosa* in Fig. B, the embryo stops growing in length only when the tail reaches the opposite pole, as shown in Fig. A; if the egg is still smaller, the embryonic axis may continue to grow beyond the opposite pole, so that the blastoderm does not close till it reaches the point marked III beyond which the tail buds out at C. This third form also requires another mode of closure of the blastoderm, differing from the two preceding types.

In a large ovum, according to Fig. A, the embryo ceases to grow in length when it has extended itself over an arc of the yelk globe of, say, 125°; in *Alosa*, or the second form, it extends its growth through an arc of 180°; in the third and smaller type of ovum (*Carassius*), it may grow to a greater length and embrace an arc of 230° on the surface of the yelk sphere. In the first type the rim of the blastoderm is sometimes drawn out into an oval prior to closing, as shown in Fig. C taken from *Tylosurus*. These different modes of growth in length of the bodies of the embryos of different species of fishes are matters of observation with me and go far toward reconciling the differences of opinion which have been expressed by different observers as to the growth of the blastoderm over the yelk. It is evident, at any rate, that what may be observed on this point in one type may not apply to another.

The segmentation cavity *sc*, Fig. G, extends laterally, with the advance of the rim of the blastoderm, towards the opposite pole of the egg, and does not disappear, as held by Haeckel and Balfour. In Fig. E it extends between the yelk hypoblast and its epiblastic outer coverings from *a* clear to the tail *cm*, and from one side of the body down, over, and around the yelk to the other side. It may be seen developed to a remarkable extent in some forms, as in *Cybium*, *Coregonus*, and *Alosa*. Figs. 47 and 48 show it in two stages, under the blastoderm of the cod.

In *Coregonus*, the oil-drops, by their buoyancy, bulge the yelk hypoblast upwards into the cavity, so that immediately over each considerable droplet there is a perceptible rounded elevation of its floor.

The various cavities which different observers claim to have seen dur-

ing the early stages of development I believe, in some cases, at any rate, to have been purely the products of reagents. The separation of the cells during cleavage is a very probable occurrence, and originates by the cells pushing and displacing each other somewhat during this process, as suggested by Whitman. The evidence which I have been able to gather, both from the living eggs and sections, leads me to the conclusion that the *Keimhöhle* of Stricker and Œllacher is the true blastocœl of the Teleostean ovum, as Ziegler has more recently urged. The yelk hypoblast is its floor, and the at first two-layered epiblast its roof. Its development is constantly the same in all of the forms studied by me, and I have not yet found any evidence of the existence of species without the epiblastic or outer covering of the yelk-sack, as asserted by Von Baer.

I see no valid reason for not regarding the yelk as an active part of the ovum, through the intermediation of the yelk hypoblast, and it seems evident that the segmentation cavity is simply a space filled with fluid which facilitates the gliding of the blastoderm over the yelk during growth, and that it is placed between the blastoderm and the yelk, with its free nuclei peripherally displaced to a remarkable degree. In other words, I would regard the yelk as an integral part of the egg, taking a share in segmentation only at a very late period. In consequence of the almost entirely passive condition of the yelk during the earlier stages, the blastoderm is obliged to spread to an extreme degree, and in parts becomes remarkably attenuated. On this account I would still hold to the view first expressed in my paper on the development of *Tylosurus*, that the germ-disk alone is practically the homologue of the whole Batrachian or Marsipobranch ovum, since we actually do not find any intimate connection of the yelk with the embryo, except by way of the vascular system, which develops late in most forms. In *Alosa* the yelk might be removed at any stage without taking away any essential part of the embryo except the floor of the segmentation cavity. The mode of development of the gastrula and cœloma, is, we find, greatly modified by the presence of the yelk, but it is not an active factor in the development of either by means of any process of segmentation.

The free nuclei of the yelk hypoblast apparently proliferate as the blastoderm spreads. They are, at any rate, at first confined to the germinal pole of the ovum, and are only found at the opposite pole after the yelk-globe has been included by the blastoderm. The inference, therefore, is that they spread and multiply with the lateral growth of the blastoderm. It is these nuclei possibly which are the centers of certain free cells around the margin of the germinal disk when the latter has attained the morula stage, as in *Cybium* and *Tylosurus*, as shown in Fig. 3, Pl. XIX, of my essay on the latter form. If such is the case, it is possible that the germinal wall (*Keimwall*) at the edge of the blastoderm of the chick is homologous with the yelk hypoblast of the fish ovum. In fact, it is highly probable that there is a yelk hypo-

blast inclosing the true vitelline matter of the eggs of birds, reptiles, and Elasmobranchs which is altogether homologous with the same layer in the Teleostean ovum. It is also likely that it has a similar origin in all of these truly meroblastic forms, in all of which an extreme permanent displacement of the germinative vesicle also occurs.

In Fig. E, at *hy*, the hypophysis or pituitary body is shown as a dorsal diverticulum from the fore part of the mesenteron. The latter is much depressed from above and expanded laterally at this stage. The origin of the hypophysis from the fore part of the mesenteron in *Teleostei* seems to be pretty well established.

I see no difficulty in referring the development of the muscle plates of *Teleostei* to a process essentially similar to that seen in *Amphioxus*, viz, as outgrowths from the primitive hypoblast. A comparison of Figs. H and J may make this clearer.

28.—The development of the eggs of the codfish.

When the ova of the cod have been in the hatching apparatus for some time, various organisms will be found to have attached themselves externally to the vitelline membrane covering the eggs. Monads, infusoria, and algæ avail themselves of the surface of the egg membrane as a nidus upon which to fix themselves, as shown in Fig. 34, where the most conspicuous of these protégés is a bell-animalcule of the genus *Vorticella.* The monads belong for the most part to the subdivision originally characterized by the late Prof. H. J. Clark, and known as the collared flagellates. There were a few free forms observed which were not identified, however. When these organisms become attached in considerable numbers to the eggs dirt tends to accumulate on their surfaces, giving the eggs a soiled, bad appearance. The most important of these adhering organisms is a one-celled algous plant or protophyte, club-shaped, with its narrow end fixed to the egg; these are most numerous, and they contain brownish protoplasm (phycoxanthine) corpuscles which are adherent to the cell wall. Eggs kept in the liveliest motion were soonest covered with these unbidden guests. Apparatus in which there was least active movement of the water did not pollute the surface of the ova as quickly. It may be laid down as a rule that the more violent the motion of the eggs the sooner were they loaded with foreign organic growths, which no doubt has a tendency to interfere with the respiration of the embyro through the egg membrane, as well as to weight the egg so as to make it sink and smother. It is very probable that the accumulation of sediment and organisms upon the eggs may have had a great deal to do with the excessive mortality of the cod ova in the experiments at Wood's Holl. It caused least trouble in the apparatus used by Colonel MacDonald, operated by the gentle alternate rise and fall of the water by means of siphons acting intermittently.

On the twentieth day, with the water at 38° Fahr., the young fish

frees itself from the bondage of the vitelline membrane, but it has been known to hatch in thirteen days with the water at 45° Fahr., according to the observations of Mr. R. E. Earll. The time of hatching depends very much on the temperature of the sea water, according to the investigator just referred to, where he records the fact that it required as many as fifty days for the eggs to hatch with the water at 31° Fahr., or a little above the freezing point of salt water. Sars says the ova which he had caused to hatch came out in sixteen days. From what we know of the times of hatching of various species, it appears to be the rule that the greatest variation in the time of hatching is found to occur in cases where the spawning takes place with the water at a low temperature; the least variation, on the other hand, appears to occur with those species which spawn when the temperature of the water is comparatively high. An increase of temperature seems to disproportionately accelerate and abbreviate the rate and time of development, while a decrease appears to disproportionately retard and prolong the rate and time.

When the young codfish first leaves the egg membrane its tail remains crooked for some time, but soon straightens out, as noted by Sars and Earll. The embryo appears to rupture the egg membrane by spasmodic movements of the tail, which already exerts considerable force as it strikes the membrane, which tends to break open where the head lies, which is most frequently the extremity which first becomes free. This is the fact, too, with the mackerel and moonfish, but in all of these cases the tail is sometimes the first to become free. The buoyancy of the yelk will for some time tend to keep the young fish turned upon its back, but as soon as the tail has become straight they begin to right themselves.

Professor Sars has not recognized the presence of the germinal layer described by me, and his theory of impregnation is highly improbable, in the face of recent facts. Another point remains to be noticed, where he says, "One can discover, with the aid of a strong microscope, numerous oil bladders of different sizes, and scattered irregularly over the whole surface of the yelk." He alludes here to what I have denominated vesicles, since they are not stained by hæmatoxylon or carmine. As remarked in the introduction, they disappear entirely. It is certain that they coalesce, as he also observes. Are they protoplasmic corpuscles? If they are, they should stain; and if fragments of the germinative vesicle, they should be still more liable to be tinged by carmine; but they do not. Their disappearance and superficial position is positive proof that they are not oil spheres. I hold to my original interpretation, viz, that they have watery contents. To the Norwegian naturalist, however, belongs the credit of having called attention to the fact that certain fish ova float and develop at the surface of the water.

All of the species of floating ova yet investigated by the United States Fish Commission exhibit great mortality in the hatching apparatus, no

matter what may be the form of the latter. Buoyant eggs seem, in fact, to be much more sensitive to slightly unfavorable conditions than heavy or adhesive ova with thicker membranes. The floating eggs will not stand stagnant sea water for any great length of time, even at a temperature of 38°Fahr. Buoyant ova die in the latter eventually, just as certainly as heavy eggs in standing fresh water at 75°. A few ova to a large amount of water abstract the oxygen much less quickly than where the proportion of eggs is in excess of the water. The buoyancy of the cod's egg is undoubtedly due to the diminished specific gravity of the protoplasmic matter of the vitellus, and not to the presence of any oils. In this respect it represents a unique type of the buoyant ovum.

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EXPLANATION OF THE REFERENCE LETTERS USED IN THE PLATES.

A indicates the position of the embryo's head.
a. auricle.
ab. air bladder.
al. allantois, median vesicle into which the segmental ducts open.
ar. dorsal aorta.
as. asterisk.
au. auditory canal.
B. indicating the position of the tail of the embryo.
ba. bulbus arteriosus.
bf. pectoral or breast fins.
bl. blastopore.
c. caudal vein.
cc. pericardiac cavity.
ce. cerebellum.
ch. notochord or chorda dorsalis.
chs. chorda sheath.
c. pl. cell plate.
cv. first cerebral vesicle or neural sinus.
d. yelk or deutoplasm.
e. mesenteron or primitive gut.
ep. epiblast, cuticular layer mostly.
ff. primitive lateral fin-folds.
fb. cerebrum or fore-brain.
fc. choroidal fissure.
h. heart.
hy. hypoblast; hypophysis in Fig. E.
inf. infundibulum.
g. gills, and inferior cranial arches.
gd. germinal disk.
i. intestine.
ic. intestinal constriction, pylorus. (?)
Kv. Kupffer's vesicle.
l. lens.
liv. or *lv.* liver.
m. mouth.
mo. medulla oblongata.
mc. medullary canal.
ms. medulla spinal; spinal cord.
mes. caudal mesoblast.
mi and *mi*[1]. micropyle.
mk. Meckel's cartilage.
mp. muscle-plate.
n. nucleus; neurula in Figs. E, F, H, I, J, K.
na. nasal pit.
nc. neurenteric canal or strand of cells.
nf. nerve filament.
œ. œsophagus.
op. optic vesicles.
p. point where the dorsal aorta joins the caudal vein.
pp. polar protoplasmic prominence.

pc. post-cardiac membrane.
pv. muscle plates; protovertebræ.
pn. pineal gland.
pr. protoplasm; protoleucite; germinal pellicle.
prn. nodose protoplasmic processes from the edge of the germinal disk.
pnp. pronephros.
pi. pigment cells.
pst. medullary plate.
pf. pectoral fold.
r. rim of blastoderm.
sv. sinus venosus.
s. ep. sensory layer of epiblast.
sh. sensory hillocks or papillæ of lateral line.
sg. segmentation cavity.
sc. segmenting corpuscles?
st. subnotochordal strand of mesoblastic cells; in part the postanal gut.
s. sagitta.
t. tongue.
v. vent.
ve. ventricle.
vt. vitelline membrane; egg capsule.
vs. vesicles imbedded in the germinal pellicle.
w. posterior wall of pericardiac cavity.
y. rudiment of air bladder and dorsal lobe ot the liver.
yb. yelk blastopore.
yc. yelk canal.

EXPLANATION OF PLATE I.

FIG. 1. Unimpregnated mature egg of the cod, showing the outer vesiculated protoplasmic germinal layer *pr*, covering the yelk. x 55.

FIG. 2. A small portion of the protoplasmic germinal layer, more magnified, showing numerous minute included vesicles. x 225.

FIG. 3. A similar portion of the protoplasm layer of an impregnated egg. The vesicles have united or become confluent, larger, and less numerous. x 225.

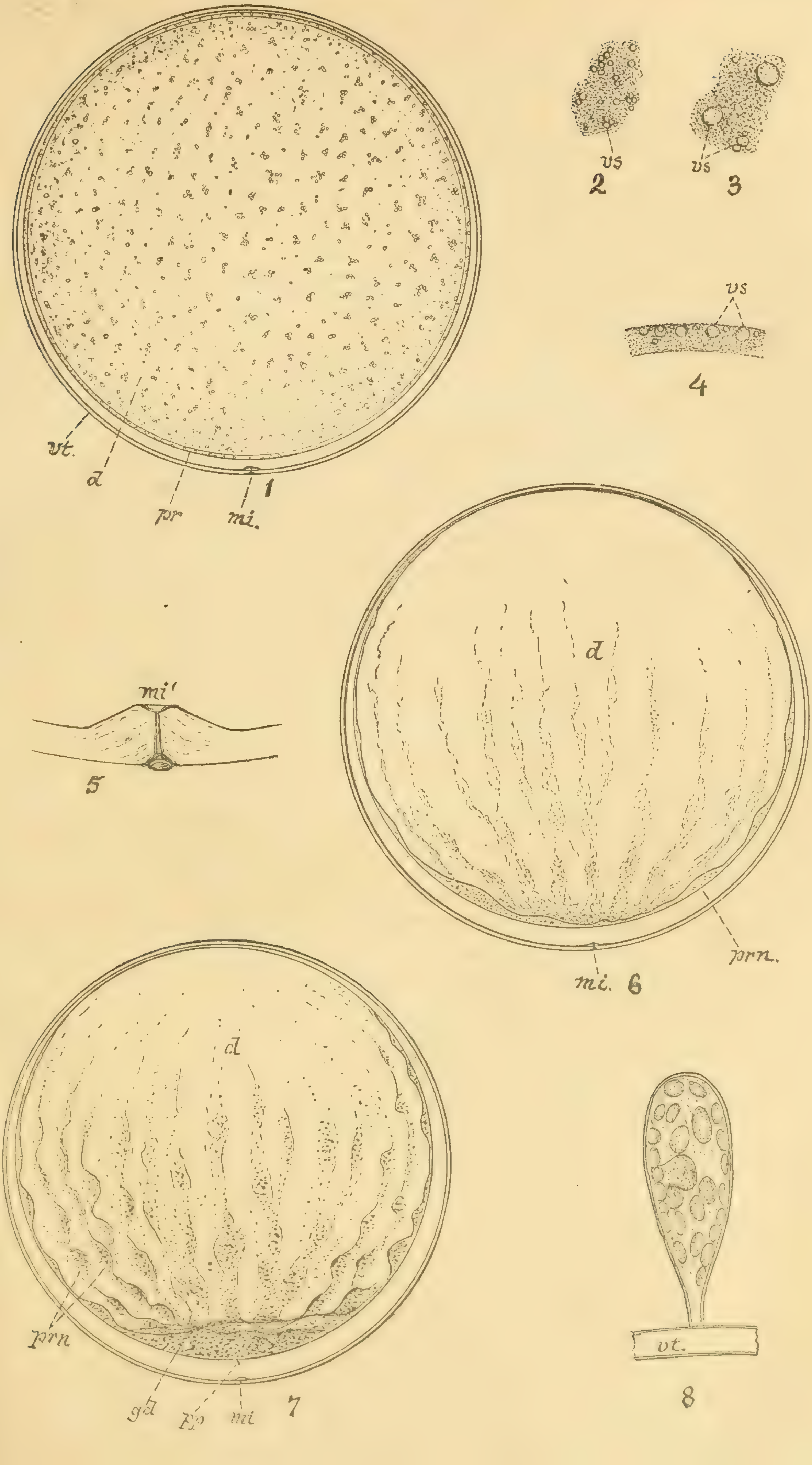
FIG. 4. A stage between 2 and 3, showing the protoplasmic layer in section, with the vesicles lying next the outer surface. x 225.

FIG. 5. A portion of the vitelline membrane in optic section, showing the structure of the micropyle. x 1200.

FIG. 6. Cod's egg one and a half hours after impregnation, the protoplasmic layer traveling in beaded streams towards the lower pole in an amœboid manner. x 55.

FIG. 7. Cod's egg three hours and forty minutes after impregnation, with the germinal disk defined, and the beaded protoplasmic processes extending outwards and upwards from it, clasping the yelk. x 55.

FIG. 8. Algous growth, containing brown chlorophyll bodies, found attached in great numbers to the vitelline membranes of developing eggs of the cod. x 500.



vt.
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rp
mi
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8

EXPLANATION OF PLATE II.

FIG. 9. Cod's egg eight hours after impregnation, the germinal disk undergoing division into two halves, viewed from below; oblique illumination. x 30.

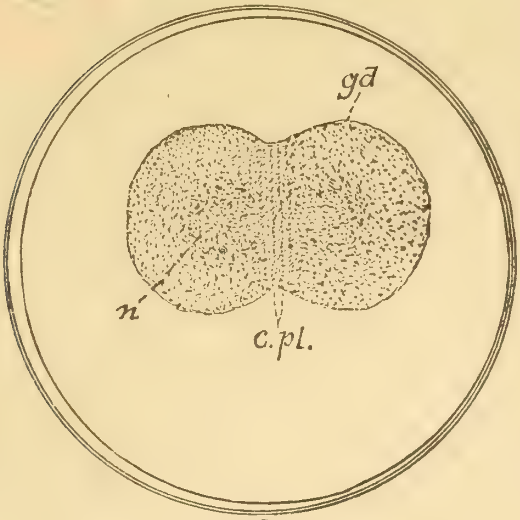
FIG. 10. Germinal disk of cod's egg nine and a half hours after impregnation, showing the completion of the second cleavage through its longest diameter dividing each of the first two cells of the preceding figure, resulting in four new ones. The nuclei and granular contents of the cells shine through in this and the foregoing figure. Oblique illumination. x 30.

FIG. 11. Cod's egg twenty-three hours after impregnation; the disk is shown at lower side of the yelk, viewed from the side. x 30.

FIG. 12. The germinal disk of the preceding, viewed from below, showing fourteen cells, the products of further cleavages. x 30.

FIG. 13. Cod's egg forty-five and a half hours after impregnation, in optic section, showing still further progress in the cleavage of the disk, as a result of which about three superimposed layers of cells have been formed. x 50.

FIG. 14. Cod's egg four days after impregnation, showing a still further advance in cleavage, through which a multicellular disk (morula) has arisen, which is very strongly convex on the inner side towards the yelk. x 50.



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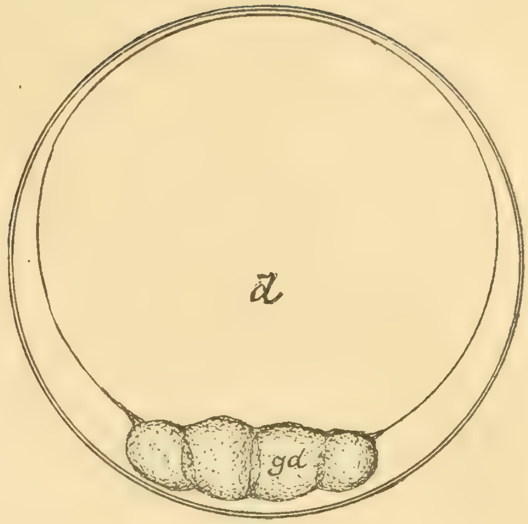

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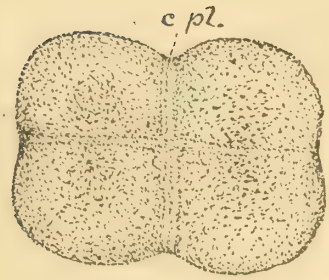

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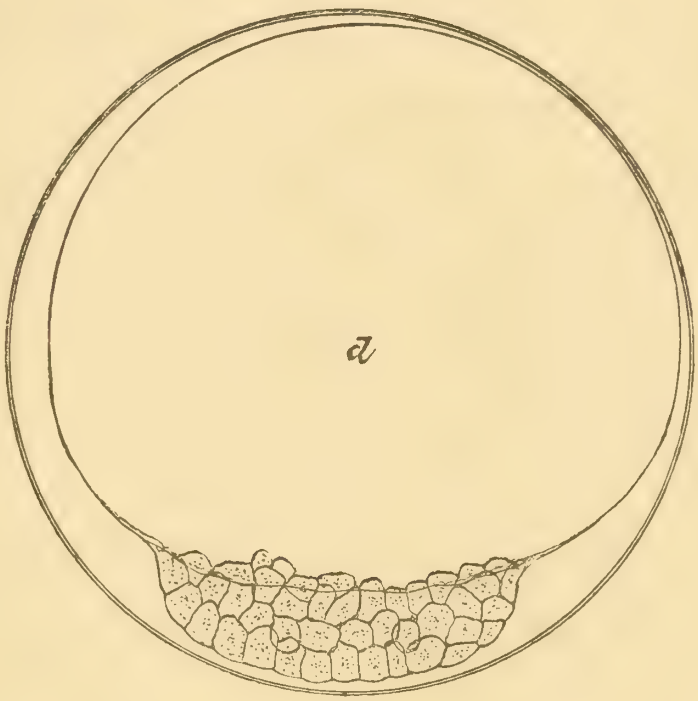

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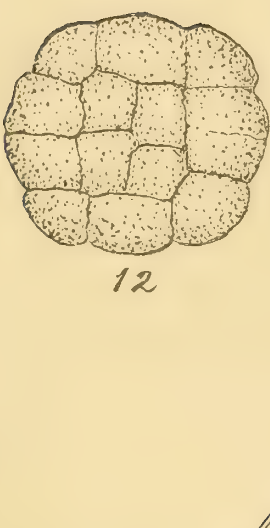
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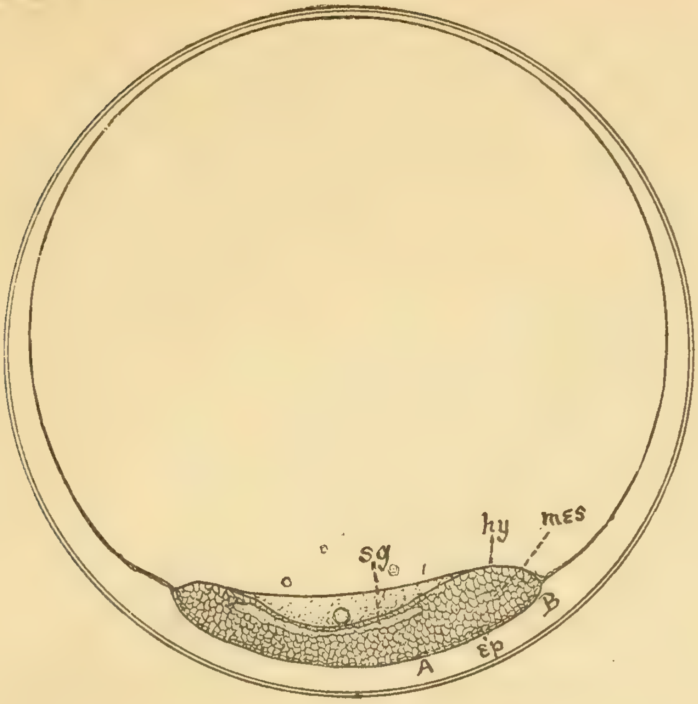
EXPLANATION OF PLATE III.

Fig. 15. Cod's egg seven days after impregnation, with the concave blastoderm fully formed, and viewed from the side in optic section, and beginning to spread laterally over the yelk; a segmentation cavity *sg* has been developed, and the epiblast and hypoblast may be plainly distinguished in the right-hand portion extending from A to B, the extremities of the axis of the embryo lying in the embryonic disk. The floor of the segmentation cavity is drawn too distinctly. x 50.

Fig. 16. The same blastoderm viewed from below, showing the contour of the segmentation cavity *sg*, with the embryonic disk lying below it, and embracing the lower half of the blastoderm, with the position of the head end of the embryo fish indicated by the rounded margin of a cellular area just below A, from which its axis extends to B at the margin. x 50.

Fig. 17. Blastoderm of a cod's egg in outline of the seventh day, further advanced and larger than the foregoing; the segmentation cavity has altered its contour but slightly, but the axis of the embryo has been somewhat elongated from A to B. x 55.

Fig. 18. The same blastoderm viewed in section along the axis of the embryo, showing greater concavity below than in Fig. 15. The thickened portion from A to B clearly displays the two principal embryonic layers, to the right of which the segmentation cavity is seen in section, extending down to the thickened rim *r* of the blastoderm. x 55.



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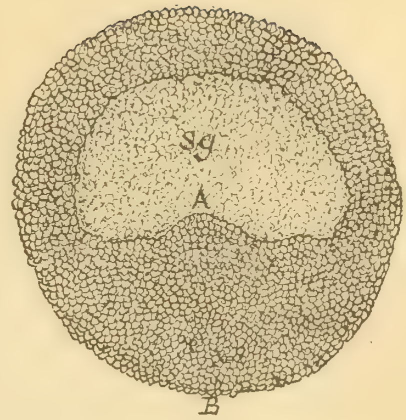

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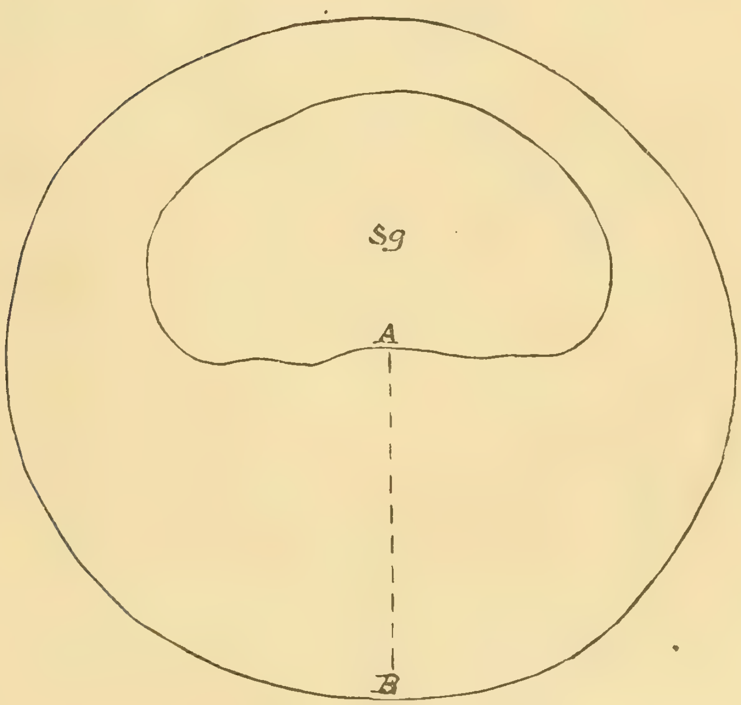

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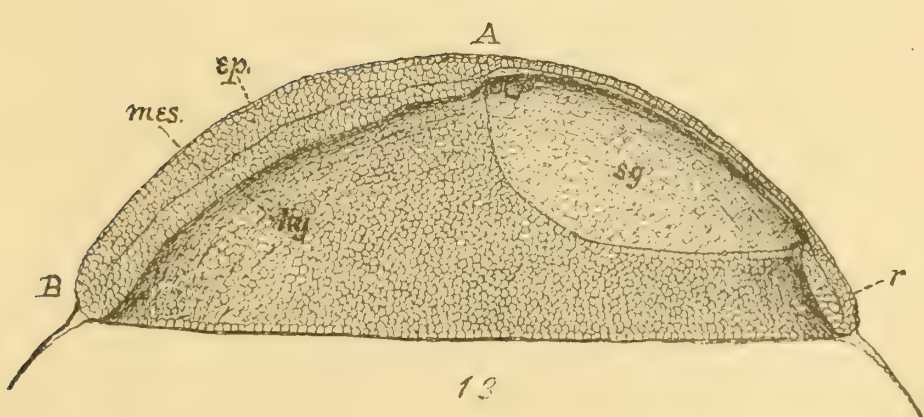

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EXPLANATION OF PLATE IV.

FIG. 19. Cod's egg on the eighth day, showing the appearance of the neural or medullary plate *p. st*, the contour of the segmentation cavity *sg*, and the blastodermic rim *r* continuous with the embryo, viewed from below. x 57.

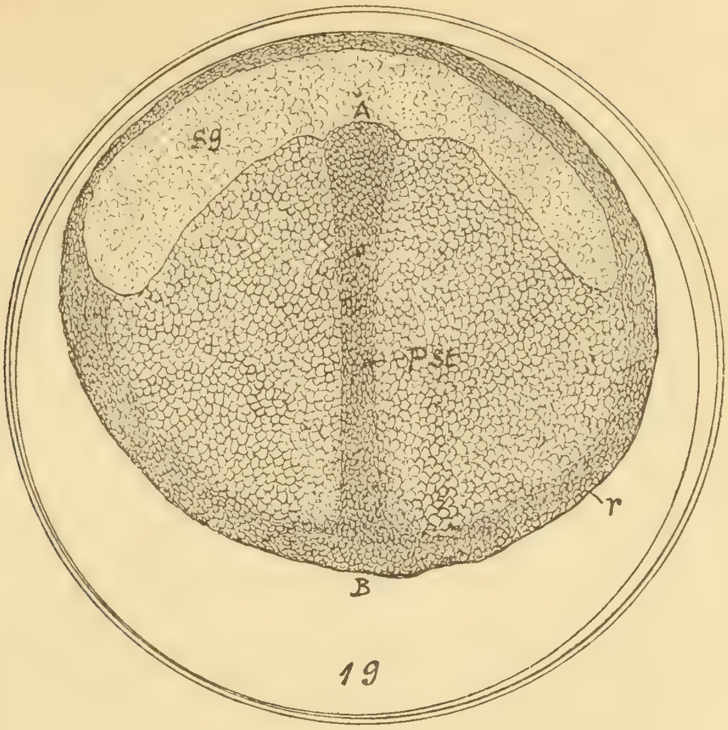
FIG. 20. Cod's egg on the ninth day after impregnation, showing the embryo from the side, the head being already defined as a well-marked thickening to the right of A, with indications of the optic vesicles. x 30.

FIG. 21. Embryo of the same age, viewed obliquely, with the head directed forwards; the cerebral structures forming, with indications of the beginnings of the optic vesicles at the sides of the head at *op*. x 30.

FIG. 22. Embryo ten days old; the blastoderm has grown very considerably, and all of the yelk which now remains exposed is that above the blastodermic rim *r;* the lumen of the segmentation cavity is seen to extend from the head at A to the lower edge of the blastodermic rim at the left side. The optic vesicles are defined, and the first cerebral vesicle has been formed and become very much flattened laterally or compressed, so that its "keel" dips down into the yelk very considerably.

FIG. 23. Embryo somewhat older than the preceding (the body only being shown); the first pair of muscular segments *pv* have appeared on either side of the neural or medullary canal and the chorda dorsalis *ch* below it.

FIG. 23 *a*. The head of the same from directly in front, showing the flattened cerebral vesicles and optic vesicles in section.



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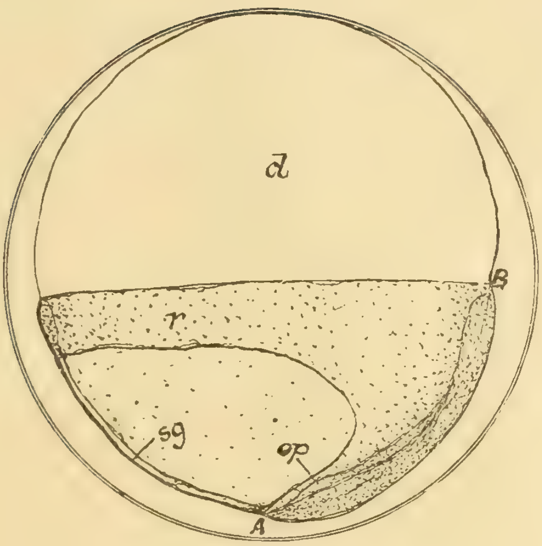

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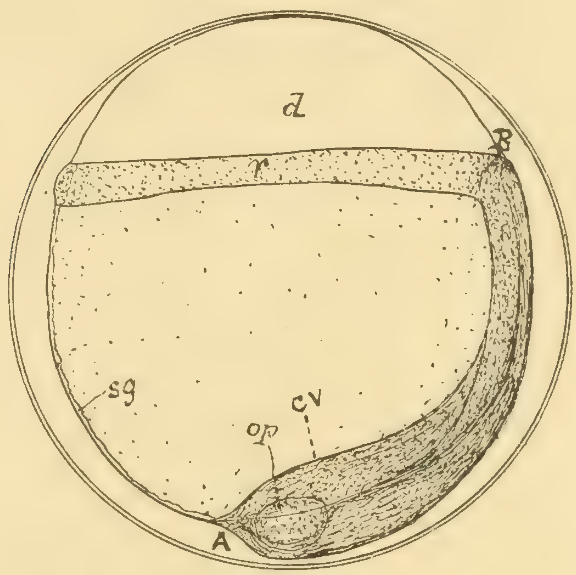

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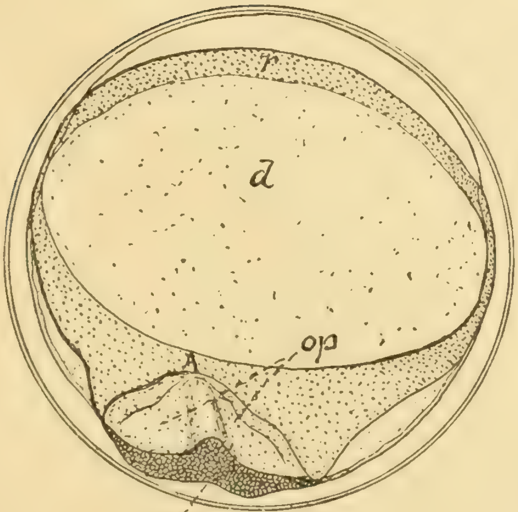

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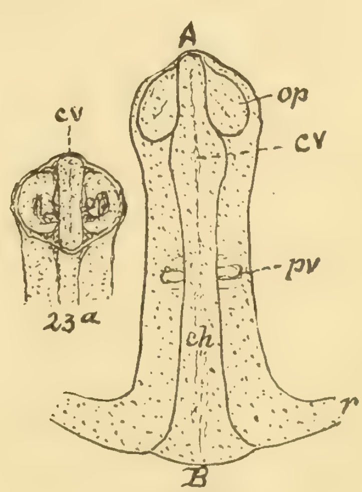

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EXPLANATION OF PLATE V.

FIG. 24. Tail of embryo cod on the thirteenth day, viewed from below, showing the position of the yelk blastopore *bl*. x 55.

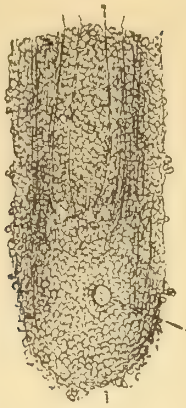
FIG. 25. The same seen somewhat obliquely from the side, with the chorda dorsalis shining through.

FIG. 26. Embryo cod fourteen days old, seen from below. x 55.

FIG. 27. Head of an embryo eleven days old, viewed from above, nearly as far advanced as Fig. 26, in optic section, showing the structure of the head. x 150.

FIG. 28. Head of embryo seventeen days old, from the side, showing the lumen of the heart *h*, the nasal and auditory vesicles, the vesicles of the primary divisions of the the brain, lateral longitudinal fold *ff* of the right side, which develops into the pectoral or breast fin.

FIG. 28 *a*. Tail of an embryo cod, looking nearly at its end, showing the blastopore *bl* and the lumen of Kupffer's vesicle *kv*. x 55.



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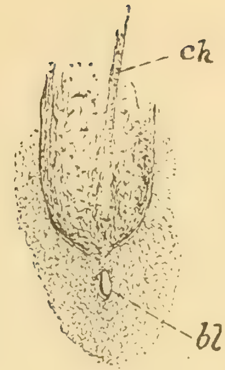

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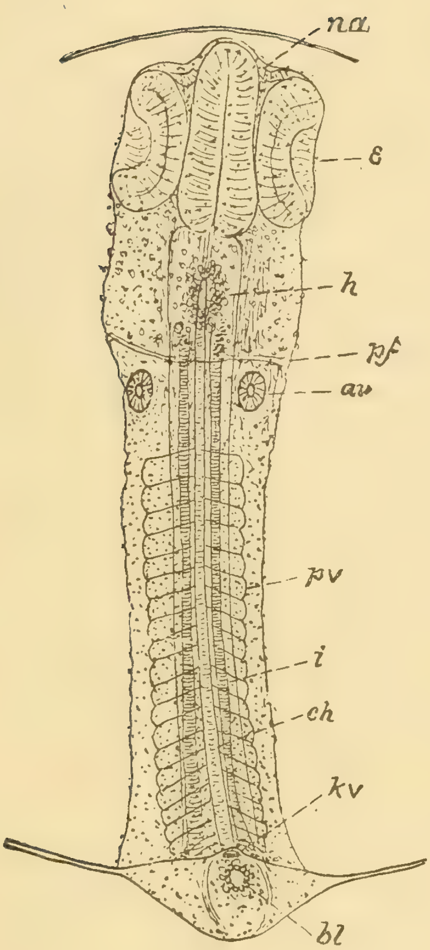

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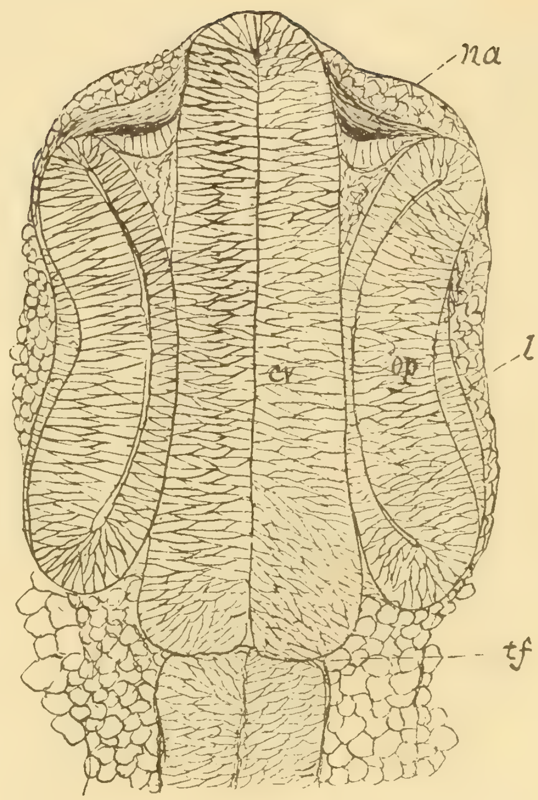

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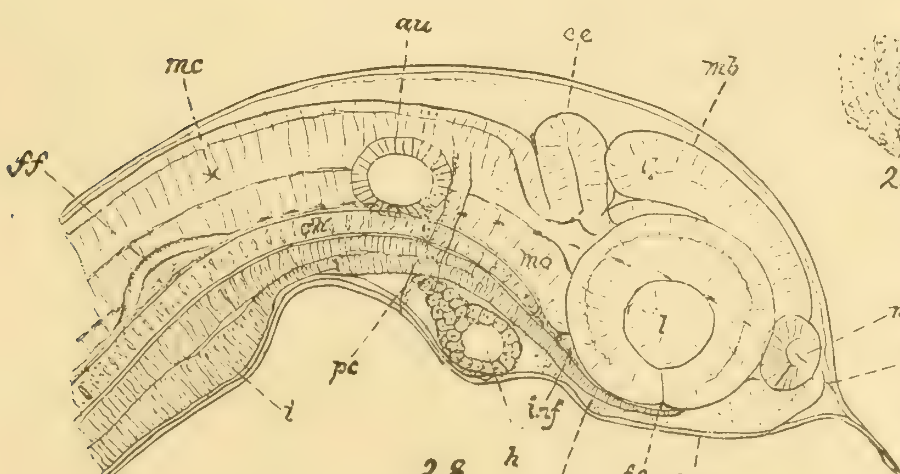

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28 a

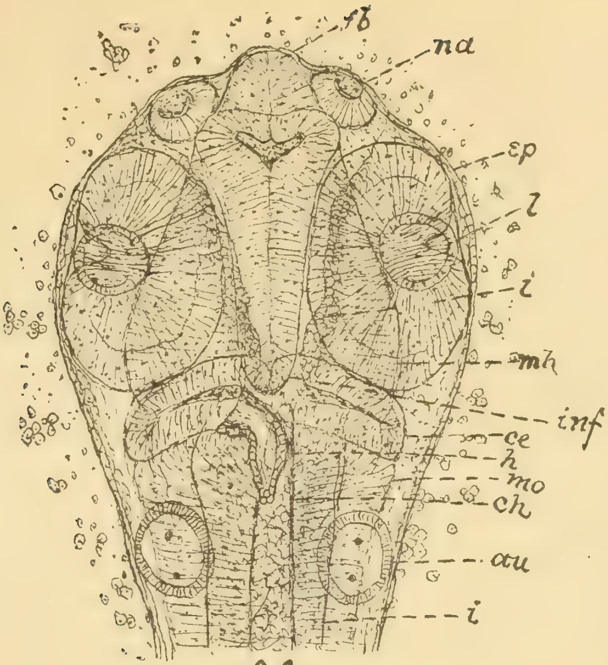
EXPLANATION OF PLATE VI.

FIG. 29. Head of embryo cod seventeen days old, viewed from below, showing the cerebral vesicles differentiated, and the hypoblastic and mesodermal tracts of cells *i*, from which the trabeculæ cranii, etc., are developed. The anterior dilated extremity of the embryonic heart is bending to the left, and is destined to become the auricle and venous sinus. x 55.

FIGS. 29 *a* and 29 *b* represent the caudal ends of embryos thirteen days old, and relate to the history of the blastopore and Kupffer's vesicle. x 55.

FIG. 30. Head of embryo cod fifteen days old, showing the disposition of the tissues in the head region, indicated by the large rounded cells. The heart *h*, as compared with Fig. 29, is a mere spherical sinus or cavity, with a wal of mesodermal cells. x 65.

FIGS. 30 *a* and 30 *b* relate to the history of the blastopore. x 55.



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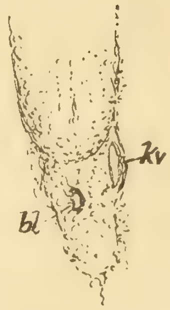

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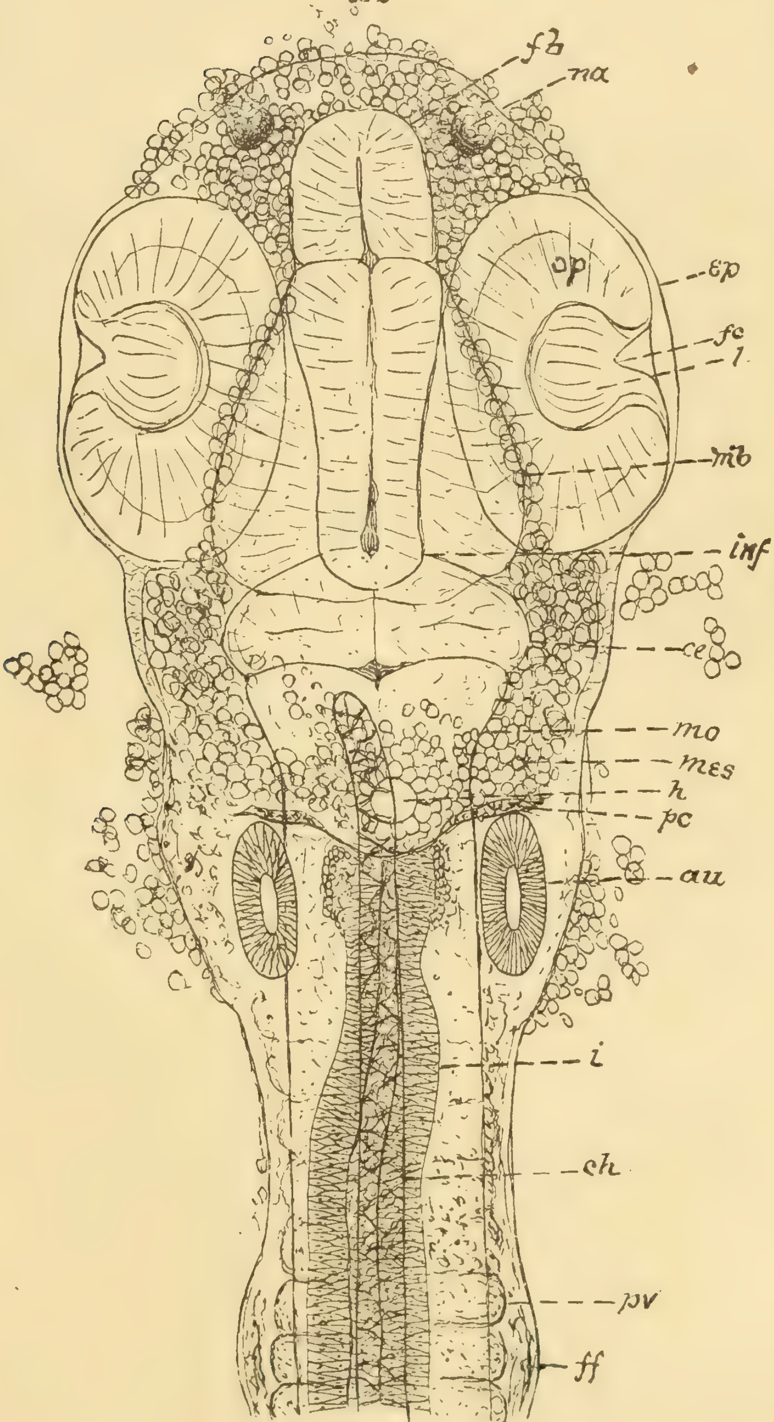

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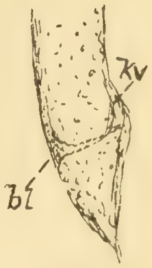
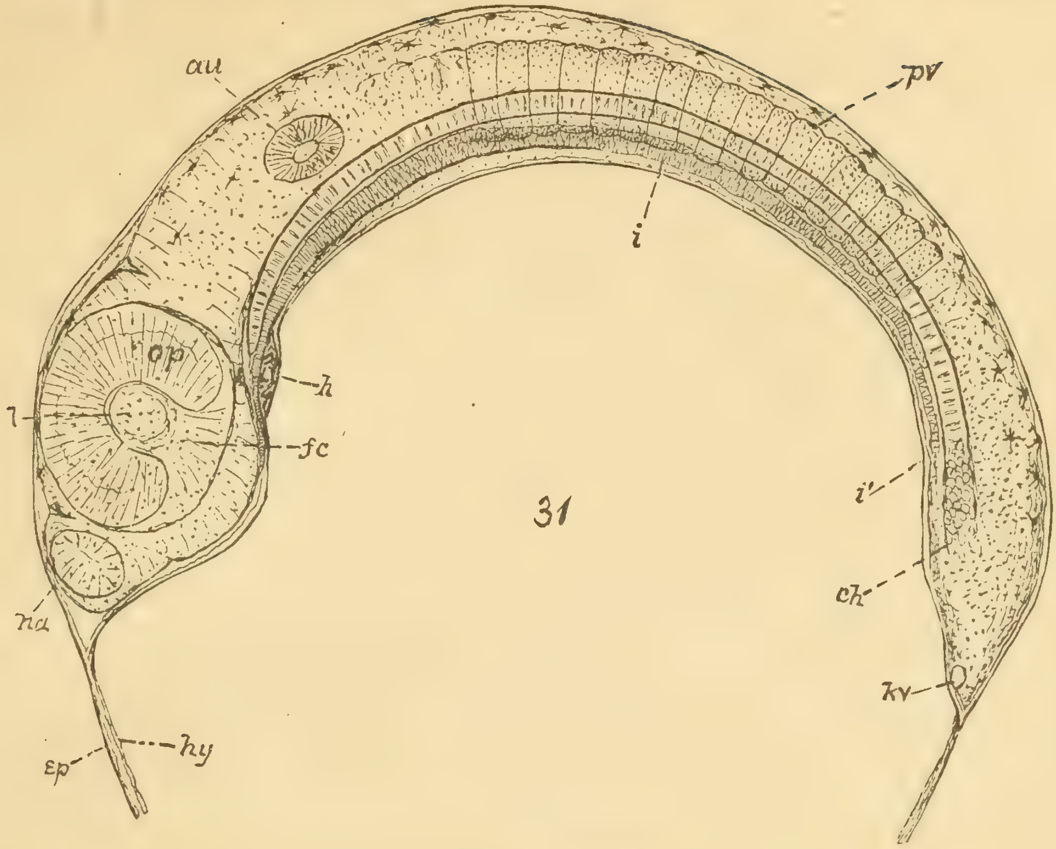


30b

EXPLANATION OF PLATE VII.

FIG. 31. Embryo cod fourteen days after impregnation, seen from the side in section, showing the optic cup *op*, with the choroid fissure *fc* entering it below. The rudimental intestine is already clearly defined, and the hinder extremity of the chorda dorsalis *ch* is enlarged, and composed of small cells, while the anterior portion is hyaline, inclosing transversely placed lenticular nuclei. Kupffer's vesicle is present, and stellate pigment cells have made their appearance. x 55.

FIG. 32. Embryo cod sixteen days after impregnation, viewed from the side in section. The tail has become free and is twisted over to one side, lying with one of its sides against the yelk and the other against the vitelline membrane The rudiment of the liver has made its appearance as a thickening of the ventral wall of the primitive intestine, at the hinder extremity of which the position of the vent has been defined. The lateral fin-fold *ff* is now distinctly developed as a short longitudinal ridge. x 55.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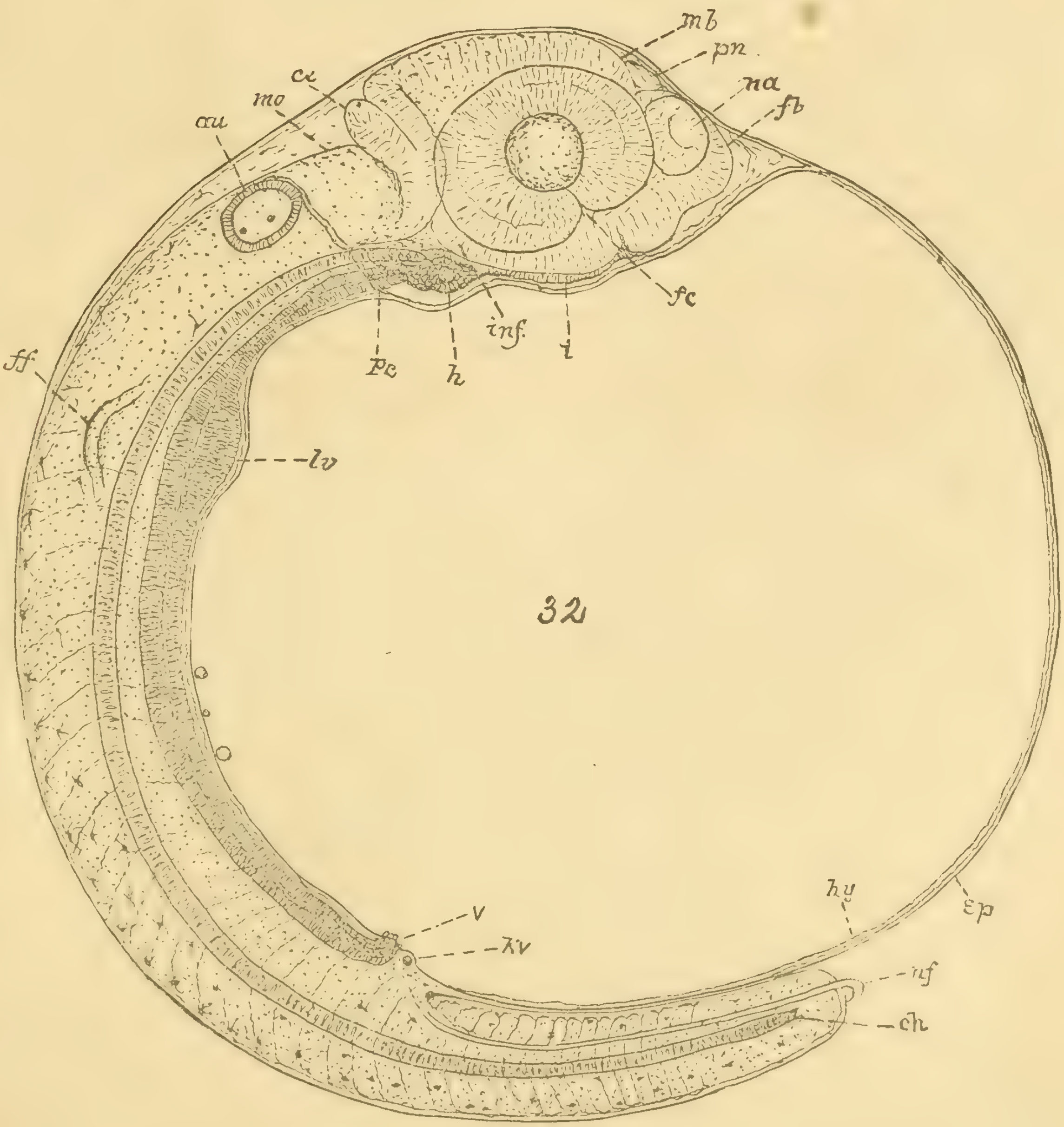
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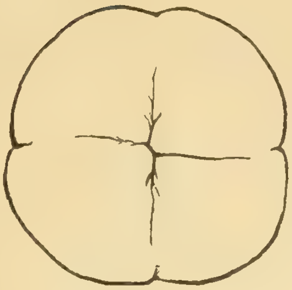
EXPLANATION OF PLATE VIII.

FIG. 33. Transverse optical diagrammatic section through the region of the fin-folds of an embryo cod eighteeen days after impregnation, showing the relation of the spinal chord *ms* to the chorda dorsalis *ch* and the intestine *i*, with the muscle plates *pv* and segmental ducts *sd* on either side. x 55.

FIG. 33 *a*. Germinal disk of cod's egg divided into four segments, and showing dislocation of the second cleavage furrow. x 32.

FIG. 33 *b*. Germinal disk of shad's egg of two hours, divided like the preceding, and with the second and third cleavage furrows dislocated. x 18.

FIG. 34. Embryo cod nineteen days after impregnation. The liver, heart, tail, fin-fold, brain, and intestine have made important progress. The heart now pulsates regularly, but there are as yet no blood corpuscles. The eye is beginning to develop an outer layer of pigment, the lamina fusca. The muscle segments or plates have become more numerous. At the upper right-hand side a bell-animalcule, some monads, and an alga are shown attached to the vitelline membrane. x 55.



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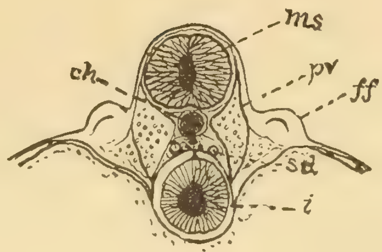
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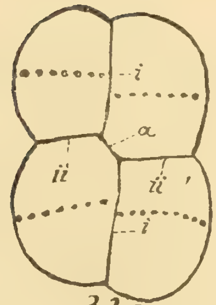
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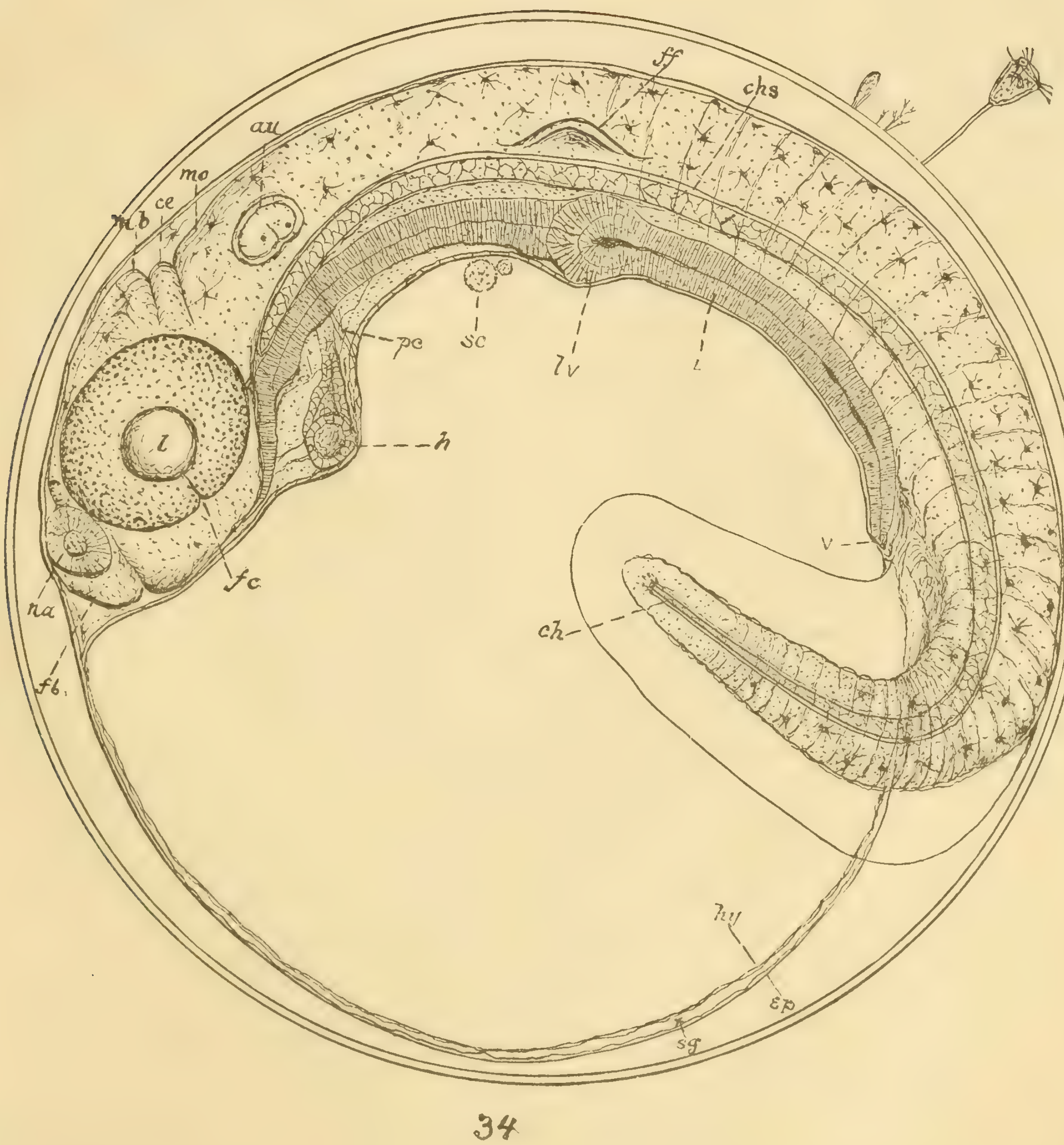
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EXPLANATION OF PLATE IX.

FIG. 35. Germinal disk of cod's egg four hours old.

FIG. 36. A similar disk in an abnormal condition.

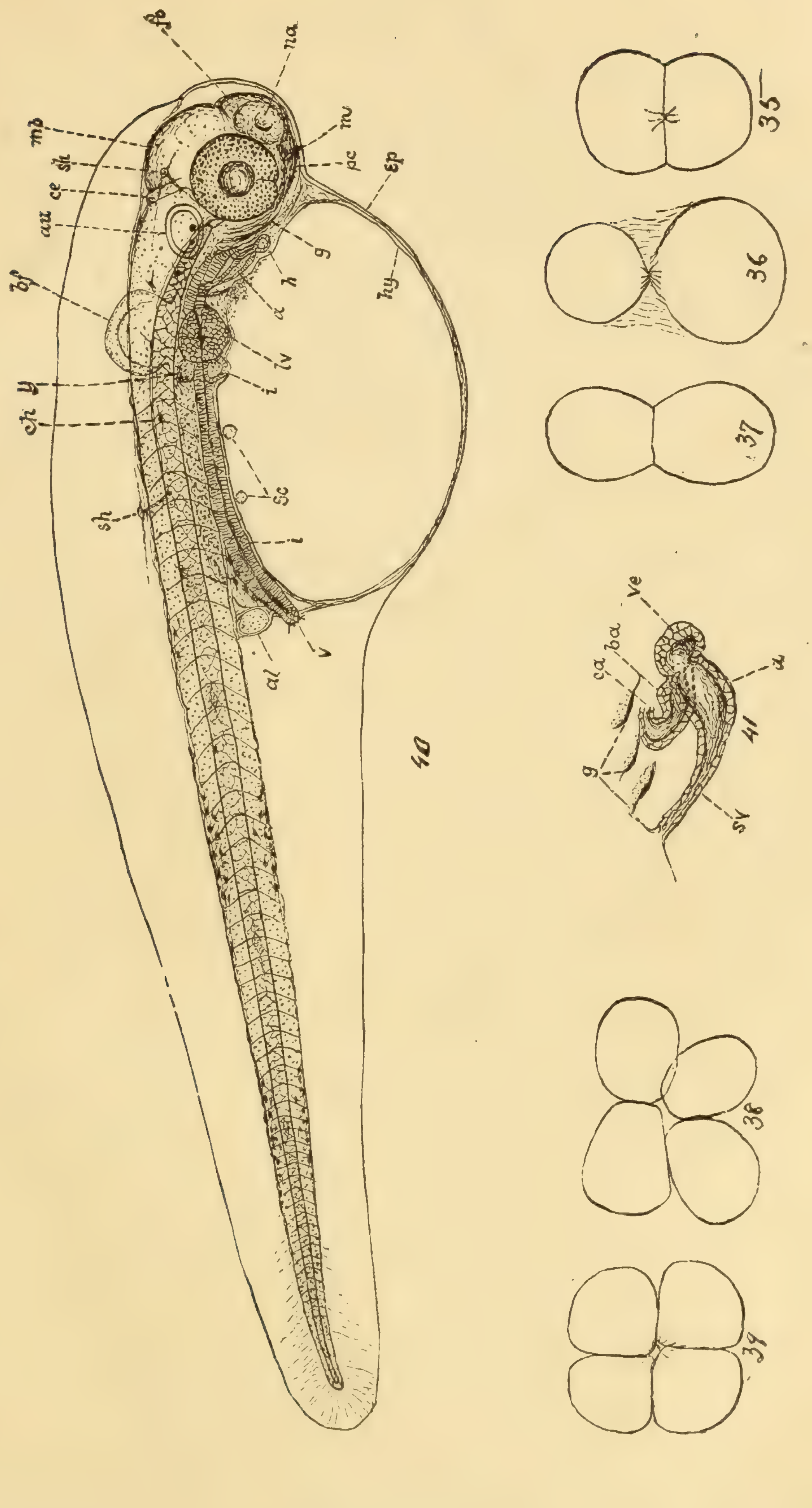
FIG. 37. Another abnormal form.

FIG. 38. Germinal disk of cod's egg past the second cleavage, and consisting of four cells; an abnormal form.

FIG. 39. A similar disk six and a half hours old, normally developed. All of the five preceding figures are magnified thirty-two times.

FIG. 40. Embryo cod twenty-two days after impregnation, which has escaped from the egg twenty-four hours since, seen from the side. The gill clefts now show distinctly as parallel furrows which have barely just broken through behind and below the eye. The heart has also been differentiated into its four principal divisions, and the venous sinus has its mouth directed upwards and backwards. The brain is relatively shorter and deeper, and the position of the future mouth is indicated at *m*. The allantois *al* is now clearly visible as a large vesicle above the vent *v*. The liver *lv* has been still further differentiated, together with the air bladder *y*. Lateral sensory elevations, which are connected by a nervous thread to the spinal cord, surmounted by fine hairs, have appeared in the epiblast or epithelium of the young fish at *sh*, *sh*. The breast fin *bf* is now nearly circular in outline, but its base still has a longitudinal direction. x 40.

FIG. 41. Heart of the above, more enlarged, showing its cellular structure and its four principal chambers. x 100.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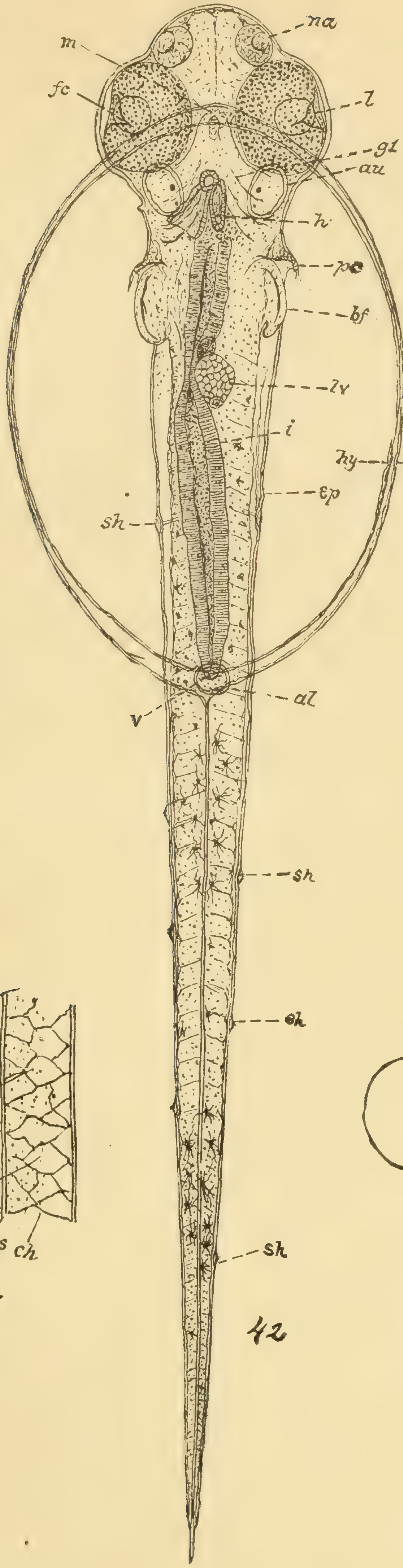
EXPLANATION OF PLATE X.

FIG. 42. Embryo cod twenty-one days after impregnation, one day out of the egg, seen from below. The positions of the sensory elevations *sh* are indicated at the sides of the tail. The inner hypoblastic covering of the yelk *hy* and the outer epiblastic covering *ep* are shown in optic section, with a space between them all around—the remains of the segmentation cavity. The position of the mouth *m* is indicated as well as that of the gill arches *g* 1. The heart, seen from below, is bent upon itself, and the course of the intestine *i* is somewhat asymmetrical. The vent lies just below the allantoic sac. The stellate pigment cells have aggregated in two patches behind the vent on both the ventral and dorsal sides of the tail. x 45.

FIG. 43. One of the lateral sensory elevations of the preceding specimen in section showing the nerve filament *nf*, which joins it to the spinal cord. The elevation itself is seen to be only a thickened portion of the epiblast *ep*, surmounted by sensory filaments *sp*. The relations of the muscle plates *pv*, the chorda *ch*, and its sheath *chs* are also shown. x 120.

FIG. 44. Germinal disk in the condition of the first cleavage of cod's egg four hours old. x 32.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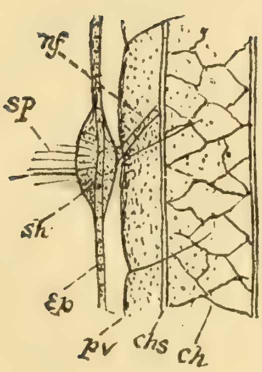
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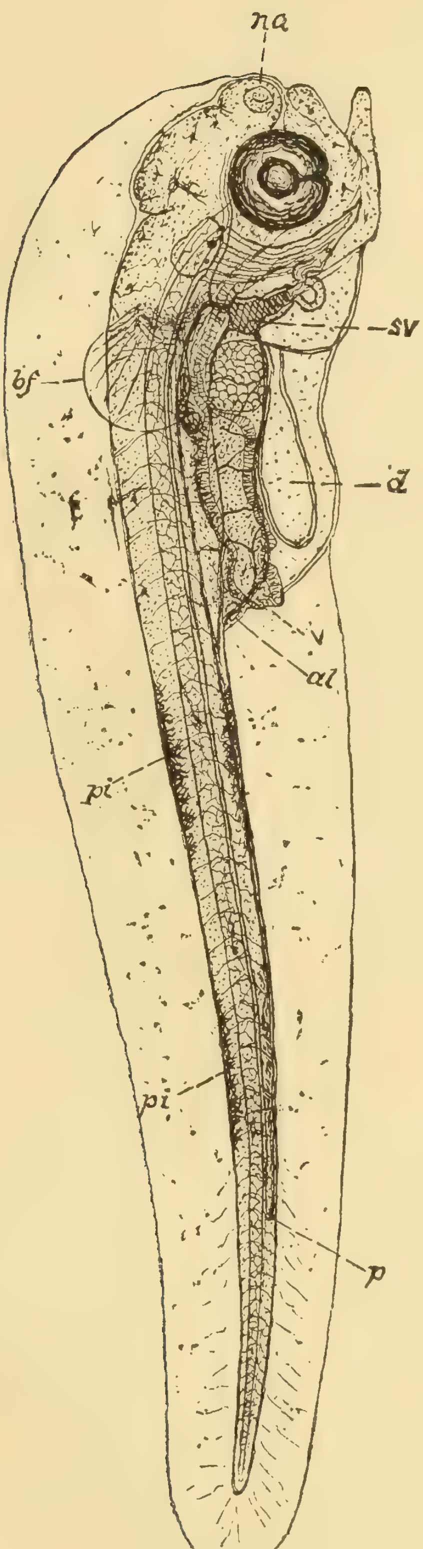
EXPLANATION OF PLATE XI.

FIG. 45. Young codfish thirty days after impregnation and ten days after it has left the egg, showing the high dorsal natatory membrane or median fin-fold, of the forward part of the animal reminding one of the form of the dolphin of ancient sculptures. We note but little difference as compared with the younger stage, shown in Fig. 49, except that the blood system has been more fully developed, the dorsal aorta turning upon itself at *p* on the under side of the tail, to become the caudal vein, which splits up into cardinal branches anteriorly, which give off vessels which pass over the viscera in front of the allantois to finally empty into the venous sinus. At no time has there been a true omphalomeseraic system developed, since the heart does not even pulsate until some time after the tail begins to form. x 25.

FIG. 46. Embryo cod twenty-three days after impregnation, from below, showing the pectoral folds *pf*, the œsophagus *œ*, the heart, and the rudimentary gill clefts *g*. The mouth *m*, the maxillary hyoidean, and gill arches are indicated, while the pericardiac septum *pc*, intervening between the heart space and body cavity, is also shown. x 40.

FIG. 47. Four days' blastoderm of cod's egg in optic section, to show the extent of the segmentation cavity. x 32.

FIG. 48. A similar disk four and a half days old. x 32.



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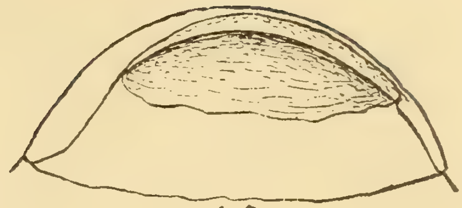

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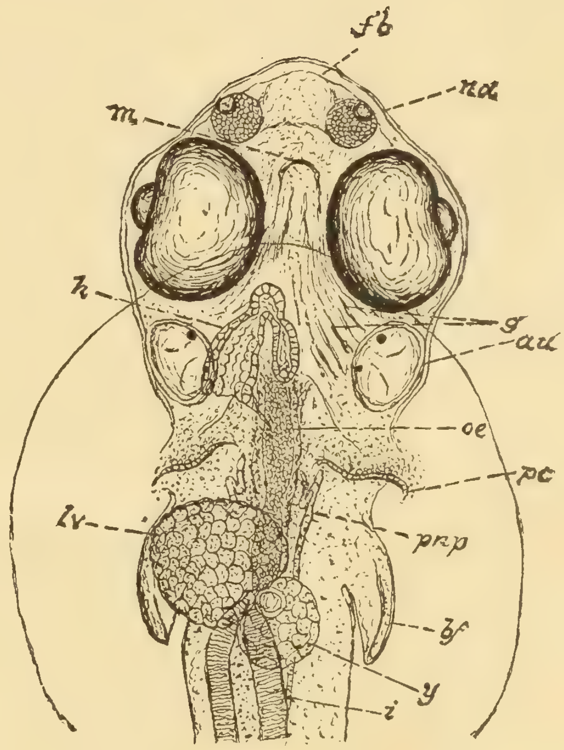

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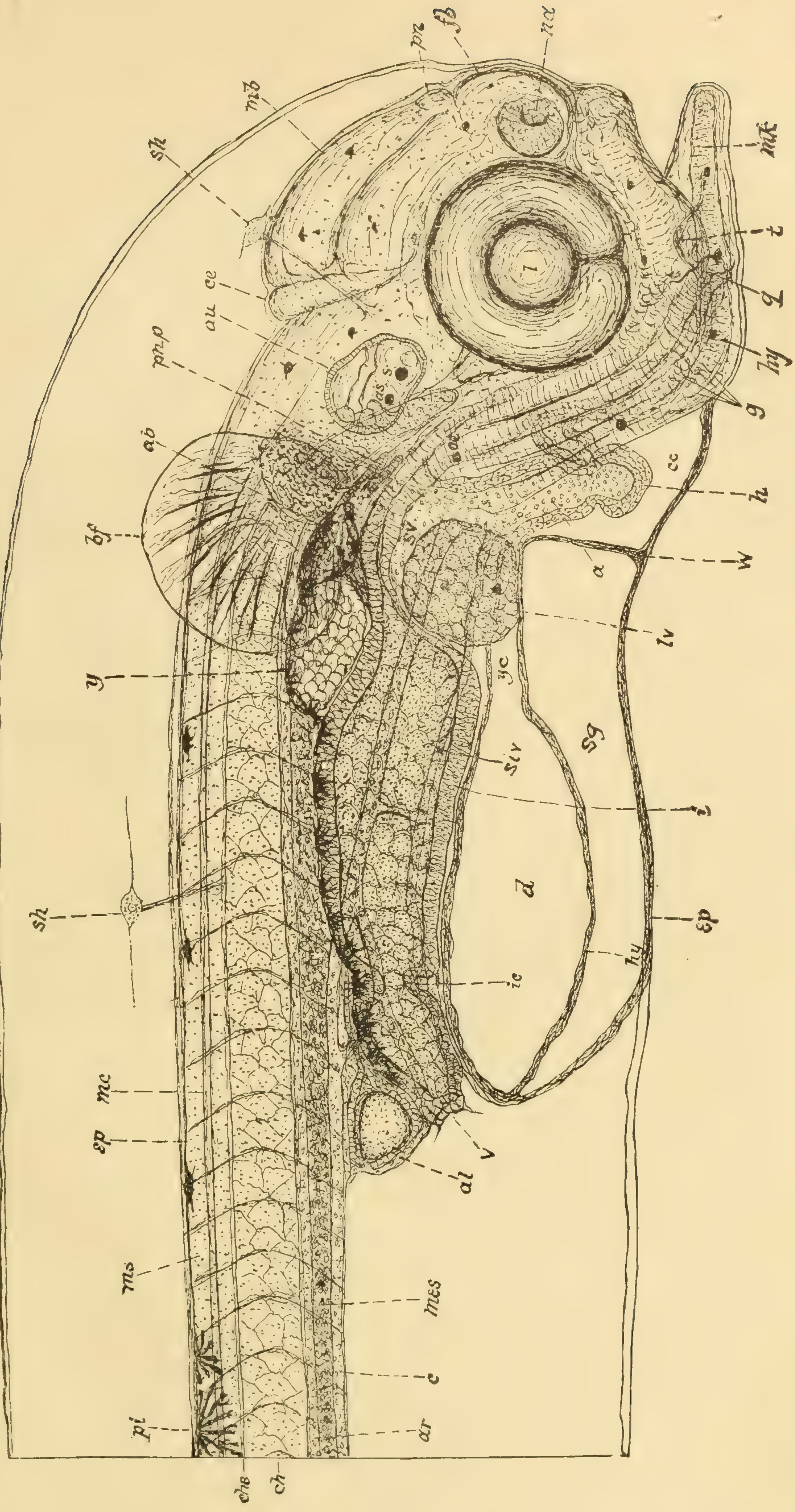
EXPLANATION OF PLATE XII.

FIG. 49. Head of embryo cod on the twenty-seventh day after impregnation and one week after hatching, seen from the side. The breast fin has assumed a nearly vertical position. Meckel's cartilage forms the skeletal basis of the lower jaw, and the palatopterygoid cartilage and quadrate constitute the major portion of the sides of the upper jaw. The tongue *t* is supported by a glosso-hyal, followed by other hyal cartilages, to which are attached the curved cartilaginous rods which support the gills *g*. The mouth is now wide open, and the young fish snaps its jaws vigorously. The circulation has been established; a dorsal aorta and caudal vein now traverse the mesoblastic tissue *mes* below the chorda, and the blood corpuscles have acquired a reddish tinge. The yelk-sack *d* is being gradually emptied of its contained deutoplasm. The splanchnopleural covering of the forepart of the yelk-sack has been pushed upwards, and now forms the hinder wall of the pericardiac cavity *cc*. The liver *lv* is more distinctly developed than formerly, and occupies a lower position in the visceral cavity above it, and dorsad of the structure *y* has increased in size, and appears to represent the dorsad portion of the rudimentary liver, while in front of it lies the air-bladder proper, covered with pigment cells. In front of the air-bladder again a convoluted tubular organ *pnp* may be distinguished, the pronephros. The allantois *al* has undergone little advancement, but the intestine can now be divided into three regions: that of the gullet from *œ* to the liver, the mid-gut region from the liver to the constriction *ic*, and the hind-gut from *ic* to *v*. The auditory vesicle *au* has undergone further development, inasmuch as the semicircular canals are defined, the ingrowing ridges from the walls of the primitive vesicle having met and divided the cavity into the rudimentary ampullæ and canals, while the otoliths asterisk *as* and sagitta *s* are seen in place. The dermal sensory elevations *sh* are seen to have filamentous prolongations backwards and forwards which will probably connect them into a continuous lateral series, the rudiment of the lateral line system of the adult. The complicated stellate pigment cells *pi* have aggregated together in definite tracts on the tail and over the endothelium (peritoneum) of the visceral cavity. x 85.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INDEX.

[Ryder's Embryography of Osseous Fishes.]

XVIII.—ON THE PRESERVATION OF EMBRYONIC MATERIALS AND SMALL ORGANISMS, TOGETHER WITH HINTS UPON EMBEDDING AND MOUNTING SECTIONS SERIALLY.

By John A. Ryder.

The question frequently asked of the investigator is, "How shall I preserve the materials I may collect for you?" This is a very important question, because, unless eggs, embryos, or small portions of animals which are to be studied microscopically by means of sections are properly prepared to begin with, it is often impossible for the embryologist or histologist to get satisfactory results. And from personal experience I may remark that there is nothing more mortifying to the student than to find a rare and valuable, or perhaps unique, specimen ruined beyond repair by the preliminary "preparation" it has suffered at the hands of persons either ignorant of proper preservative methods or indifferent in regard to their application. Alcohol, so universally used as a preservative, can be made to yield splendid results if properly employed, but if applied without discrimination or an understanding of the end in view, it may utterly ruin otherwise valuable materials if it is desired to use them in the prosecution of delicate anatomical or histological investigations. The shrunken, distorted, alcoholic specimens too often seen in our museums are a reproach to science, and it is high time that more care was exercised in the preparation of such objects, as it would not only be to the advantage of the systematist, but also to the anatomist and histologist, to say nothing of the better appearance which would be presented by such properly prepared collections of zoological materials.

The directions which follow are meant to be useful to those seeking information as to the proper mode of preparation to be applied to such delicate objects as embryos or small soft organisms which are to be transmitted to the National Museum in the best possible condition. Some suggestions under the heading of alcohol are also intended to apply to the care and preservation of large objects.

Vessels.—As receptacles for specimens, vials, jars, or bottles with conveniently wide mouths should be selected. Their form is of small consequence, provided they are sufficiently large to accommodate the object without distorting it, and with a mouth wide enough to admit of the removal of the specimen without injury after it has become indurated by

the preservative agent. They should also be capable of being closed securely so as to guard against leakage when packed for shipment, and also to prevent evaporation when stored away in the cabinet. Rubber corks are probably the best for small vials in which it is designed to preserve small embryos or small organisms.

Crowding a large number of small specimens into one vial is wrong, and abundant space should left besides the specimens for accommodation of a sufficient amount of the hardening reagent or the preservative fluid which may be used, otherwise it is not possible in most cases to harden the specimens uniformly and quickly, because there is not enough of the reagent around the specimens. Delicate embryos are often distorted in the process of killing and hardening, so as to be bent and twisted, which makes it difficult to get the axis of their bodies into a single plane, which is very desirable, especially if it is intended to prepare serial sections with the newer forms of the sledge microtome. In order to avoid such distortion as much as possible, if embryos or other small animals are killed and hardened immediately in the vials, it is best to cork the latter and lay them on their sides so that the objects, especially if slender, do not rest in a mass on the bottom, but on the undermost side of the vials. These precautions should be borne in mind in handling recently hatched fish embryos, the tails of the latter being especially liable to become bent and distorted by the weight of those overlying those on the bottom of the vial if the latter is placed upright while the process of hardening is in progress.

Packing and labeling.—It is of the utmost importance that small, delicate objects should be carefully packed in the bottles when it is proposed to ship them, so that they may not be shaken about, especially if moderately large; unless this is done important portions may be broken off and lost after the specimens have been hardened by the preservative. To avoid this, the specimen, if large, should be wrapped in pieces of cheese cloth, which may be secured around the object with string. If the objects are small wrapping them carefully in soft tissue paper will be found expedient, or if the bottle should not be full, soft tissue paper crushed into springy masses may be used to fill up the vacant space in the bottles, care being taken that the packing of paper is not forced in too tightly so as to injure the specimens. Paper is better for this purpose than cotton wool, which, in the case of specimens which have hooked teeth or processes projecting from the body frequently becomes entangled with such processes as to cause them to be torn off when the specimens are unpacked. Finally, it is a good rule in packing to fill the vials full of the preservative fluid, which keeps the specimens immersed and also prevents injurious shaking when shipped.

Not less important than the packing is the proper labeling of the specimens. Every vial, if containing only a single specimen or a single series, should be labeled with the date of collection, the locality, and the name of the collector. If a number are sent in the same vessel, each

distinct specimen or distinct series should be wrapped separately and have a label securely attached, giving the date of collection, locality, &c. In the case of embryos, care should be taken to record the age of the different series where this is known, and in the cases of fishes, amphibians, and some articulates, this may be known very exactly. To prepare a series of embryos of fishes, for example, and especially where their eggs are artificially hatched in some kind of hatching apparatus, it is very easy to prepare a series of specimens at intervals of, say, every twelve to twenty-four hours, and to place the separate lots of different ages in different vials, so that the investigator may use the material so prepared in a very complete study of the development of the form. In the preparation of such series it is important to give the date, and, if possible, the hour of the day when the eggs were impregnated, and to indicate upon a label within or pasted on the outside of the bottle, the exact age of the contents. The locality and collector's name should also be given. Labels placed within the vials so as to be immersed in the preservative agent should not be written in ordinary ink, but with a soft lead-pencil, as common writing ink is liable to become effaced from the paper by the solvent action of the preservative fluid. India ink, according to Semper, when dissolved in strong acetic acid, makes a black marking fluid which will remain perfectly black and legible in alcohol for years.

PRESERVATIVE AGENTS.

All of the best preservative agents tend to harden animal tissues.

Alcohol.—When alcohol of 95 per cent. is used it should almost always be diluted. One of the few cases in which 95 per cent. or absolute alcohol may be used to advantage is in the preservation of sponges, as I am informed by Dr. Benj. Sharp. These may be immersed in the very strongest alcohol as soon as they are removed from the water, a recent investigator having found that for the study of their minute structure this was the best preservative medium, after the unsatisfactory trial of a great many. The collared flagellate cells lining the respiratory and digestive cavities of these organisms are thus best preserved.

In almost all cases, however, the use of very strong alcohol is followed by more or less extensive and injurious shrinkage of the object, especially if it is very soft and watery, as in the cases of embryos, polyps, and mollusks, more particularly. In these cases the mixture first used should consist of alcohol, 1 part; water, 10 parts.

If the object is small or of moderate size it may be left in the above twenty-four hours, then transferred to a mixture of alcohol, 1 part; water, 3 parts, or to a mixture of alcohol, 1 part; water, 2 parts, according to the consistency of the object, and in which it may remain for two or three days and then be transferred to alcohol, 2 parts; water, 1 part, and, after a day or two, into 95 per cent. alcohol, if the specimen is intended for histological purposes.

With care and attention an organism as soft as the oyster may be hardened and preserved in common alcohol by gradually increasing the strength of the preservative solution, so that there is little or no perceptible shrinkage. The cause of shrinkage is the removal of the water of organization by the alcohol, and, in the case of badly prepared specimens, it will usually be found that the first bath of alcohol into which the object was plunged was too strong and had caused the withdrawal of the water of organization much too rapidly and produced an excessive shrinkage, much to the injury of the specimen. Some investigators recommend very strong alcohol for the preservation of brains, which it is desirable to harden as rapidly as possible and without distortion. In the case of such soft objects, especially if they are of considerable size, they should be suspended in the preservative fluid by a string attached to the cork, in order that the specimen's own weight may not distort it while the process of hardening is in progress, the distortion being aggravated by any curved or uneven surface upon which such a soft object may rest.

In the case of comparatively large objects, such as mammals and fishes, the body cavity should be filled with 40 per cent. alcohol by means of a syringe, so as to enable the preservative to act from within as well as from without. In the case of fishes, which are usually thickly covered with slime, especially such species as the eels, hags, and lampreys, the slimy coating should always be washed off before immersion in alcohol.

Dr. Whitman*, speaking of the use of alcohol says: "In the preparation of animals or parts of animals for museums or histological study, it is well known that the chief difficulties are met with in the process of killing. Alcohol, as commonly used for this purpose by collectors, has little more than its convenience to recommend it. Dr. Mayer has called attention to the following disadvantages attending its use in the care of marine animals:

"(1.) In thick-walled animals, particularly those provided with chitinous envelopes, alcohol causes a more or less strong maceration of the internal parts, which often ends in putrefaction.

"(2.) In the case of smaller crustacea *e.g.* Amphipods and Isopods, it gives rise to precipitates in the body fluids, and thus solders the organs together in such a manner as often to defy separation even by experienced hands.

"(3.) It fixes most of the salts of the water adhering to the surface of marine animals, and thus a crust is formed which prevents the penetration of the fluid to the interior.†

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* Methods of Microscopical Research in the Zoological Station in Naples, Am. Nat. XIV, pp. 697–706 and 772–785, 1882.

† Dr. Mayer first noticed this in objects stained with Kleinenberg's hæmatoxylin, and afterwards in the use of cochineal, where a gray-green precipitate is sometimes produced which renders the preparation worthless. Such results may be avoided by first soaking the objects a few hours in *acid alcohol* (one to ten parts hydrochloric acid to one hundred parts seventy per cent. alcohol.)

"(4.) This crust also prevents the action of staining fluids, except aqueous solutions of the latter, by which it would be dissolved.

"Notwithstanding these drawbacks, alcohol is still regarded at the Naples Aquarium as an excellent fluid for *killing* many animals designed for preservation in museums or for histological work. In many cases the unsatisfactory results obtained are to be attributed not to the alcohol *per se*, but to the *method* of using it. Most of the foregoing objections do not, as Dr. Mayer has expressly stated, apply to fresh-water animals; and Dr. Eisig informs me that he has no better method of killing marine annelids than with alcohol. Judging from the preparations which were kindly shown to me, and which were all beautifully stained with *borax-carmine*, Dr. Eisig's mode of treatment must be pronounced very successful. The process is extremely simple: a few drops of alcohol are put into a vessel which contains the annelid in its native element, the sea water; this is repeated at short intervals until death ensues. After the animal has been thus slowly killed, it may be passed through the different grades of alcohol in the ordinary way (as described above), or through other preservative fluids. Objects killed in this manner show no trace of the external crust of precipitates which arises where stronger grades of alcohol are first used. The action of the alcohol is thus moderated, and the animal, dying slowly, remains extended and in such a supple condition that it can easily be placed in any desired position. The violent shock given to animals when thrown alive into alcohol of forty to sixty per cent, giving rise to wrinkles, folds, and distortions of every kind is thus avoided, together with its bad effects."*

Acid alcohol.—Dr. Whitman also says, "In order to avoid the bad effects of alcohol, such as precipitates, maceration, etc., Dr. Mayer recommends *acid alcohol*, 95 volumes, 70 per cent.; or, 90 per cent. alcohol, 3 volumes hydrochloric acid,† for larger objects, particularly if they are designed for preservation in museums. The fluid should be frequently shaken up, and the object only allowed to remain until thoroughly saturated, then transferred to pure 70 per cent. or 90 per cent. alcohol, which should be changed a few times in order to remove all traces of the acid. For small and tender objects, acid alcohol, although preferable to pure alcohol, gives less satisfactory results than picro-sulphuric acid."

"*Boiling alcohol.*—In some cases among the arthropods, Dr. Mayer has found it difficult to kill *immediately* by any of the ordinary means,

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* [Embryo fishes may be killed without distortion by exposure to the fumes of chloroform. The embryos are placed in a watch-glass in water, or in a ring on the plate of a compressorium, when a few drops of chloroform are placed alongside of the watch-glass or ring filled with the water containing the embryos, and the whole covered with a larger watch-glass or bell-glass, and left a few minutes till the embryos are killed in their fully extended condition. The interesting collembolan, *Smynthurus*, may be killed in chloroform or ether with its remarkable bifurcate collophore fully extruded.]

† Acid alcohol as above prepared loses its original qualities after standing some time, as ether compounds are gradually formed at the expense of the acid.

and for such cases recommends *boiling absolute alcohol*, which kills instantly. For *tracheata* (insects) this is often the ouly means by which the dermal tissues can be well preserved, as cold alcohol penetrates too slowly."

It will be profitable to lay down the following general principles respecting the use of alcohol:

(1) *In almost all cases where soft tissues or objects are to be prepared, either for museum or histological purposes, it is best to at first immerse the object in weak alcohol, and to gradually increase its strength so as to extract the water of organization by degrees, and thus avoid the injurious shrinkage and distortion due to the use of too strong a mixture.*

(2) Sometimes it is desired to preserve a very large, soft object in alcohol, but, at ordinary temperatures, decomposition often begins in the center of the object before the alcohol has had time to completely saturate the object. Decomposition of this sort may be hindered and even prevented by placing the vessel containing the object in moderately strong alcohol in a refrigerator kept at a little above freezing. This prevents decomposition, and gives the alcohol time to saturate the object. Any other hardening agent may be applied in the same way to large objects, but in such cases care must be taken that the solution is not frozen during the process. Solutions of Müller's fluid or chromic acid may be frozen; alcoholic solutions not so readily, unless they are very dilute.

We have considered *alcohol* first as a *preservative*, *killing*, and *hardening* agent, because it is the best known and most generally used and has not yet been superseded by any of the many compounds which have been suggested as substitutes, mainly on the score of their cheapness.

Muller's fluid.—For convenience this compound probably ranks next in value to alcohol, as a temporary preservative agent and as a hardening fluid. The formula for its preparation is as follows:

Bichromate of potash	5 parts.
Sodic sulphate	2 "
Distilled water	200 "

This makes an orange-colored solution in which embryos, small animals, and pieces of tissue may be preserved for histological purposes. And it possesses one important advantage over chromic acid in this, that the object may be left in it for a month without injury, although it darkens albuminous substances permanently like chromic acid and may be objected to by some on this account. Nevertheless, it is a very convenient preservative compound in cases where the care and attention required in the use of better reagents cannot be applied to the preservation of such materials on account of their numbers or when the collector is traveling, with only occasional opportunities for overhauling and caring for his collections.

A convenient way for the traveling collector to carry the "stock" for this mixture is to have the solid ingredients put up in bulk by an apothecary. The bichromate of potash should be pulverized in a mortar, so as to dissolve the more readily, and mixed with sodic sulphate in the proportion of 5 parts to 2 of the latter. This mass can then be weighed out into parcels of 1 ounce, 1 dram, 1 scruple, which is exactly the quantity of solid material needed to mix with 1 quart of water (wine measure). These parcels containing the dry powder ready mixed can then be carried conveniently and the fluid mixed, to the amount of a quart at a time, whenever required.

After the objects have been kept in this solution for a month or so, they should be transferred to about forty times their own volume of water and the water changed every day for two or three days, in order to get rid of the bichromate of potash, when the specimens may be transferred to 70 per cent. alcohol. It has been objected that Muller's fluid produces precipitates in the cavities of objects, but there are few preservatives which do not, and on account of the convenience with which it may be used by collectors, it is, next to alcohol, probably, one of the most useful of all hardening and preservative compounds.

Chromic acid.—Solutions of this substance have been extensively used for the *hardening* of embryological and histological materials, and either alone, or, better still, in combination with other substances, is still recognized as one of the most useful reagents for this purpose. Whitman, speaking of it, says: "Chromic solutions have, in common with *osmic acid*, the peculiarity of hardening by virtue of the chemical combinations which they form with cell-substances, and all the consequent disadvantages with respect to staining. The use of chromic acid in the zoological station of Naples may be said to have been largely superseded by *picro-sulphuric acid*, *corrosive sublimate*, and *Merkel's fluid*, for it is now seldom used except in combination with other fluids. It is sometimes mixed with Kleinenberg's fluid, for example, when a higher degree of hardening is required than can be obtained by the use of the latter fluid alone. It is a common error to use too strong solutions of chromic acid, and to allow them to act too long. Good results are in some cases obtained when the objects are treated with a weak solution (one-third to one-half of 1 per cent.) and removed soon after they are completely dead." Weak solutions of one-half to one-fourth of 1 per cent., or even less, are also recommended by Semper, who allows it to act only for a short time, or until the cells are killed. But it is important in any case that as much as possible of the acid should be extracted by subsequent immersion of specimens treated with it in water or weak alcohol, since its presence often renders subsequent staining with carmine difficult. It interferes with the staining by means of the aniline dyes much less perceptibly, and in the case of some of those most diffusible and soluble in alcohol or water scarcely at all. Flemming uses exceedingly dilute solutions of chromic acid in order to fix the cleavage

figures and asters developed in eggs during their early stages of development. For this purpose he uses solutions of chromic acid of one-tenth of 1 per cent. to one-half of 1 per cent.

Dr. Whitman has recently discussed its unsuitableness when used alone in the treatment of pelagic fish-eggs in the American Naturalist for November, 1883. He writes: "The transparent eggs of various *Teleostei* floating on the surface of the sea present unusual difficulties in the way of hardening. I have had recourse to all the fluids commonly used for this purpose, and have failed to find any satisfactory method of hardening the yelk. Even the germinal disk cannot be well preserved by any of the ordinary hardening agents. Kleinenberg's picro-sulphuric acid, for instance, causes the cells all through the cleavage stages as well as the later embryonic stages to swell, and in many cases to become completely disorganized. The embryonic stages can be hardened in chromic acid (1 per cent.), but the yelk contracts considerably without becoming well hardened even after three days' immersion.

"All sorts of wrinkles and distortions are caused when the ova are transferred from the acid to the alcohol; my best results have been obtained with osmic acid and a modified form of Merkel's fluid. This fluid, as used by Dr. Eisig, consists of chromic acid (one-fourth per cent.) and platinum chloride (one-fourth per cent.), mixed in equal parts. Thus prepared it causes maceration of the embryonic portion of the egg. By using a stronger chromic acid (1 per cent.), and combining it as before with the same quantity of platinum chloride (one-fourth per cent.), everything may be well preserved and hardened except the yelk. Before transferring to alcohol, after one to two days' immersion in this fluid, it is necessary to prick the egg membrane in order that the alcohol may reach the egg readily, otherwise the membrane wrinkles badly and often injures the embryo.

"For the cleavage stages this fluid cannot be used with success unless the egg has been first killed by another agent; for eggs placed in this fluid continue to live for a considerable time, and may even pass through one or two stages of cleavage. It is therefore necessary to use some agent that kills almost instantly. For this purpose, I have found osmic acid the best reagent. The eggs are placed in a watch-glass with a few drops of sea-water, and then a quantity of osmic acid ($\frac{1}{2}$ per cent.), equal to that of the sea-water, is added. After five to ten minutes the eggs are transferred to the mixture of chromic acid and platinum chloride, and left for twenty-four hours or more. This fluid not only arrests the process of blackening, but actually bleaches the egg.

"After this treatment it is an easy matter to separate the blastoderm from the yelk by needles, and the preparations thus obtained can be mounted *in toto* or sectioned. As the blastoderm is quite thin during the cleavage stages, a whole series of these stages may be mounted and studied from the surface to advantage. After removal from the acid the

preparations may be stained at once, and then treated with alcohol and mounted in balsam."

The following directions for the preparation of the tongues of *mammalia*, for histological purposes, have been furnished by Mr. Edward B. Poulton, of Oxford, England, in a letter to Prof. G. B. Goode, from which the following extract is taken:

"It is well to cut out the organ, including the epiglottis. In the case of rare animals that cannot be obtained fresh, a tongue preserved in spirit is of great use, but is not so good as a chromic acid one of the fresh organ. The best method of preparation seems to be the following: Suspend the perfectly fresh tongue by a string in ½ per cent. solution of chromic acid,* about a quart, to which one-half pint of methylated † spirit has been added. (Three or four small tongues might be put in together; a very large tongue would need more.) Leave in this solution for a week, and then change it, and after another week place the organ in a pint of solution consisting of two parts water, one part methylated spirit or alcohol, and after a few days or a week place in a pint of fluid consisting of one-half water and one-half spirit; and then, after a week, in one pint of liquid consisting of two parts spirit and one part water, and then in strong spirit, which need not be so much as one pint. In this a larger specimen will keep any length of time, and is always ready for histological work. Some tongues which I worked at, given me by Professor Mosely, were in beautiful condition, and had been hardened nine years before. The first washes of spirit can be used many times for other tongues, but it is best to have a series of labeled jars with the various strengths of spirit (alcohol) in them, and pass the tongues from one into the other, from the lowest to the highest grade of spirit. This saves expense, even though it may call for an extra change of strong spirit at the end. The tongues should finally not cause the fluid to become yellow, but the first washes may be yellow (from the dissolved chromic acid). The tongues can then be packed together in one jar in plenty of strong spirit, each with a label tied to it, giving, if possible, the specific and generic names and date. Thus many can be sent together. If you ever get them, I should be very glad of spirit or fresh tongues (prepared in chromic acid) of any Edentate, Marmoset, and any South American monkey, tapir, peccary, or *Solenodon*. The chromic acid must not be used again." This last remark applies in all cases to the use of chromic acid.

Merkel's fluid.—Whitman gives the formula for the preparation of this as follows:

Platinum chloride dissolved in water	1 : 400
Chromic acid dissolved in water	1 : 400

"Professor Merkel, who employed a mixture of these two solutions in equal parts for the *retina*, states that he allowed from three to four days

* If it cannot be obtained fresh, it is still of great use to try the chromic acid up to some days after death, but not in the case of a regular spirit specimen.

† Alcohol will answer the same purpose.

for the action of the fluid. Dr. Eisig has used this fluid with great success in preparing the delicate lateral organs of the *Capitellidæ* for sections, and recommends it strongly for other annelids. Dr. Eisig allows objects to remain three to five hours in the fluid, then transfers to 70 per cent. alcohol. With small leeches I have found one hour quite sufficient, and transfer to 50 per cent. alcohol."

Whitman gives the following account of Kleinenberg's picro-sulphuric acid, now so much used in the Naples Aquarium. It is not a hardening fluid, and serves for *killing*, and thus prepares for subsequent hardening.

Perenyi's fluid.—This recently introduced hardening agent is compounded as follows:

Nitric acid (10 %)	4 parts.
Alcohol (90 %)	3 "
Chromic acid (½ %)	3 "

Objects are left in this fluid from four to five hours, then transferred for twenty-four hours to 70 per cent. alcohol; then to 90 per cent. alcohol; and finally to absolute alcohol, in which they remain for four to five days.

Picro-carmine or borax-carmine are added directly to the fluid, so that the hardening and staining of the objects take place simultaneously. The precipitates which are produced when the reagent is mixed with the coloring solutions should be removed by filtration before the objects to be hardened are introduced. Eggs and embryos prepared in this mixture are said to cut like cartilage.

"*Kleinenberg's fluid.*—*Picric acid* (saturated solution in distilled water), 100 volumes; *sulphuric acid* (concentrated), 2 volumes. Filter the mixture and dilute it with *three* times its bulk of water.* Finally add as much creosote† as will mix.‡

"Objects are left in the fluid three, four, or more hours, and are then, in order to harden and remove the acid, transferred to 70 per cent. alcohol, where they may remain five to six hours. They are next placed in 90 per cent. alcohol, which must be changed at intervals until the yellow tint has wholly disappeared.

"*Summary of Dr. Mayer's remarks on Kleinenberg's fluid.*—The advantages of this fluid are, that it kills quickly, by taking the place of the water of the tissues; that it frees the object from sea water, and the salts contained in it, and that having done its work *it may be wholly replaced by alcohol.* In this latter fact lies the superiority of the fluid over *osmic* and *chromic* solutions, all of which produce inorganic precipitates, and thus leave the tissues in a condition unfavorable to staining. Picro-

* Dr. Mayer uses the fluid undiluted for arthropoda.

† Creosote made from beechwood tar.

‡ Dr. Mayer prepares the fluid as follows: Distilled water, 100 volumes; sulphuric acid, 2 volumes; picric acid (as much as will dissolve). Filter and dilute as above. No creosote is used.

sulphuric acid does not, like chromic solutions, harden the object, but simply kills the cells.

"As this fluid penetrates thick *chitine* with difficulty, it is necessary, in order to obtain good preparations of larger *Isopoda*, insects, &c., to cut open the body and fill the body-cavity with the liquid by means of a pipette. In larger objects care should be taken to loosen the internal organs so that the fluid may find easy access to all parts.

"The fluid should be applied as soon as the body is opened, so that the blood may not have time to coagulate and thus bind the organs together. *A large quantity of the fluid should be used, and it must be changed as often as it becomes turbid.* The same rule holds good in the use of all preservative fluids. It is well, also, especially with larger objects, to give the fluid an occasional stirring up.

"In order to avoid shrinkage in removing small and tender objects from the acid to the alcohol, it is advisable to take them up by means of a pipette or spatula, so that a few drops of the acid may be transferred along with them. The objects sinking quickly to the bottom, remain thus for a short time in the medium with which they are saturated, and are not brought so suddenly into contact with the alcohol. In a few minutes the diffusion is finished; and they may then be placed in a fresh quantity of alcohol, which must be shaken up frequently, and renewed from time to time until the acid has been entirely removed.

"The sulphuric acid contained in this fluid causes *connective tissue* to swell, and this fact should be borne in mind in its use with vertebrates. To avoid this difficulty, Kleinenberg has recommended the addition of a few drops of creosote, made from beechwood tar, to the acid. According to Dr. Mayer's experience, however, the addition of creosote makes no perceptible difference in the action of the fluid.

"This fluid must not be used with objects (*e. g.*, echinoderms) possessing calcareous parts which it is desired to preserve, for it dissolves carbonate of lime and throws it down as crystals of gypsum in the tissues. For such objects *picro-nitric acid* may be used. It is prepared as follows:

Water	95 parts.
Nitric acid (25 per cent. N_2O_5)	5 "
Picric acid as much as will dissolve.*	

"Picro-nitric acid also dissolves carbonate of lime, but it holds it in solution, and thus the formation of crystals of gypsum is avoided. If much carbonate of lime is present, the rapid production of carbonic acid (gas) is liable to result in mechanical injury of the tissues, hence, in many cases, *chromic acid* is preferable to picro-nitric acid.

"Picro-nitric acid is, in most respects, an excellent preservative medium, and, as a rule, will be found to be a good alternative in those cases where picro-sulphuric acid fails to give satisfactory results. Dr. Mayer commends it very strongly, and states that with eggs contain-

* This mixture is used undiluted.

ing a large amount of yolk material, like those of *Palinurus*, it gives better results than nitric, picric, or picro-sulphuric acid. It is not so readily removed from objects as picro sulphuric acid, and for this reason the latter acid would be used wherever it gives equally good preparations."

This fluid is also said to be useful where the objects, such as arthropods, are inclosed in a chitinous skin.

For the preservation of infusoria, Blanc recommends a very dilute picro-sulphuric solution, which I give here as abstracted from the Zoölogischer Anzeiger, No. 129, by Whitman. The formula is as follows:

Picric acid, saturated solution in distilled water	100	volumes.
Sulphuric acid (concentrated)	2	"
Distilled water	600	"

"To this solution, which may be employed as it is for the larvæ of echinoderms, medusæ, and sponges, a little acetic acid (1 per cent.) is added for rhizopods and infusoria—two or three drops for 15 grams of the solution. The acetic acid is added in order to sharpen the outlines of the nuclei and nucleoli.

"This liquid is preferable to osmic acid, because it does not render the objects non-receptive to staining fluids.

"The entire process of hardening, washing, staining, and mounting can be more expeditiously performed under the cover glass than otherwise. The acid is allowed to work until the objects have become thoroughly yellow. The acid is then replaced by 80 per cent. alcohol, frequently renewed until the yellow color entirely disappears; 96 per cent. alcohol is next used, and then absolute alcohol.

"The hardened objects may be stained with picro-carmine, or, better, with an alcoholic solution of safranin. Five grams of safranin are dissolved in fifteen grams of absolute alcohol, the solution left standing a few days, then filtered and diluted with half its volume of distilled water.

"This solution of safranin is preferable to picro-carmine, because it colors more quickly, and because one can so regulate its action as to give a sharp definition to the protoplasm or the nucleus.

"After the object has been more or less deeply stained, according to the end in view, it is washed in 80 per cent. alcohol, which is renewed until a moment arrives when no visible clouds of color appear; at this moment the 80 per cent. alcohol is replaced with absolute alcohol, and this by clove oil.

"As safranin is soluble in alcohol, the process of washing will of course remove or weaken the color, but decoloration is gradual, so that one needs only to watch and apply the clove oil when the color has been reduced to the desired intensity. * * *

"The process of decoloration is not entirely arrested by the application of clove oil, contrary to Blanc's assertion, hence it should be replaced

by Canada balsam as early as possible. The same method is adapted to other microscopic animals."

In order to confine infusorians or very small embryos, so as to subject them to the foregoing treatment under a cover glass, a method which has given very good satisfaction is the following: Three very small pellets of bees-wax or bees-wax and olive oil are stuck to the one side of a cover near its margin, and arranged so as to form the angles of a triangle. The drop containing the organisms is then placed on the slide and the cover with its wax feet carefully laid upon it. A needle is then taken and its point pressed down upon the cover glass until it is forced downwards on its yielding supports and until its under surface is sufficiently approximated to the upper surface of the slide to clamp the living infusorians or embryos fast which have been placed between without actual compression. The application of the reagents may then be leisurely proceeded with without washing the objects away, as one reagent after the other is applied at one side of the cover and absorbed on the other by bits of bibulous paper.

Hertwig's method of preparing and cutting amphibian eggs.—Whitman has given the following condensed account of Hertwig's plan of dealing with amphibian ova, which would doubtless give advantageous results if applied to the treatment of fish ova which contain coarse yolk granules, which are apt to become detached from the sections in the process of mounting when the whole embryo has first been saturated with paraffine, which must be removed from the sections with warm turpentine or chloroform, or with cold benzole or xylol. The two first are the solvents which act most quickly when used for the purpose of removing the paraffine:

"Although the amphibian egg has long been a favorite object of study among embryologists—and quite as much so since section-cutting came into vogue as before—comparatively little progress has been made in overcoming the difficulties that attend its preparation for the microtome. The chief difficulties are found in freeing the egg from its gelatinous envelope, and in preparing it so as to avoid brittleness.

"The best method that has thus far been proposed for these eggs is unquestionably that of O. Hertwig, and I shall therefore give it in detail.

"1. In order to facilitate the removal of the gelatinous envelope the eggs are placed in water heated almost to boiling (90–96° C.) for five to ten minutes. The eggs are thus coagulated and somewhat hardened, while the envelope separates a little from the surface of the egg and becomes more brittle. The envelope is then cut under water with sharp scissors, and the egg shaken out through the rupture. With a little experience a single cut suffices to free the egg.

"2. By the aid of a glass tube the egg is taken up and transferred to chromic acid (one-half per cent.), or to alcohol, 70, 80, and 90 per cent. Chromic acid renders the egg brittle, and the more so the longer

it acts; therefore the eggs should not be allowed to remain in it more than twelve hours. While eggs hardened in chromic acid never change their form or become soft when transferred to water, those hardened in alcohol, when placed in water or very dilute alcohol, lose their hardness, swell up, and often suffer changes in form.

"3. Alcoholic preparations are easily stained; but chromic acid preparations are stained with such difficulty and so imperfectly that Hertwig omitted it altogether.

"There is an important difference between alcohol and chromic acid in their effect on the pigment of the egg. Chromic acid destroys the pigment to some extent, and thus obliterates, or at least diminishes, the contrast between pigmented and non-pigmented cell-layers. As the distribution of the pigment is of considerable importance in the study of the germ lamellæ, it is well to supplement preparations in chromic acid with those in alcohol, in which the pigment remains undisturbed.

"4. Eggs hardened in chromic acid were embedded almost exclusively in the egg-mass recommended by Calberla. The great advantage offered by this mass is that it supplies a sort of antidote to the brittleness of the egg. It glues the cell-layers together, so that the thinnest sections can be obtained without danger of breaking.

"5. As the dorsal and ventral surfaces and the fore and hind ends can be recognized in very early stages, it is important to know precisely how the egg lies in the egg-mass in order to determine the plane of section. In order to fix the egg in any given position in the embedding mass, Hertwig proceeds as follows:

"*a.* A small block of the hardened mass is washed in water to remove the alcohol, and in the upper surface of the block, which has been freed from water by the aid of filtering paper, a small hollow is made. This hollow is then wet with the freshly prepared *fluid* mass.

"*b.* The egg is washed in water to remove the alcohol, placed on a piece of filtering paper to get rid of the water, turned on the paper by a fine hair brush until it has the position desired; the point of the brush is next moistened and pressed gently on the upper surface of the egg, the egg adheres to the brush and may thus be transported to the hollow prepared for it in the block.

"*c.* After the egg has thus been placed in position a drop of absolute alcohol carefully applied will coagulate the 'fluid mass' with which the block was wet, and thus fix the egg to the block. The block is again washed, and finally embedded in the egg-mass."

My own experience with fish eggs, especially those of clupeoids, is that a 1 per cent. solution of chromic acid gives good results. The eggs or embryos should not be left in it more than twelve to twenty-four hours, according to their size, when, after repeated washings in water, in which they will not change even if kept in it for three or four days, they may be transferred to 30 per cent. alcohol, or even a weaker grade, then in a day or so to 70 per cent. In a few days a granular precipitate is

formed, however, which is objectionable, yet fish eggs so preserved retain their form and structural peculiarities in alcohol unimpaired for many months. For the early cleavage stages, however, I find that chromic acid is not so good; it tends to disorganize the cleavage spindles. For these, killing in some weaker reagent, such as a 1 per. cent. acetic acid solution, or the treatment suggested by Whitman in the case of pelagic fish eggs, would give better results.

In certain cases there is no need for the removal of the egg-envelope if the latter is pricked open, especially in such forms as have a large respiratory cavity around the vitellus; the envelope, as well as vitellus, may be saturated with paraffine dissolved in chloroform at about 120° to 150° F., and where the membrane is sufficiently transparent the object may be arranged in the paraffine with hot needles without difficulty, and the sections so prepared will thus not only be sections of the egg itself, but excellent sections of the membrane will also be obtained.

My method of embedding fish eggs which have been colored *in toto* with borax, carmine, or borax picro-carmine, is as follows:

a. After dehydration with about forty times their own volume of strong commercial or 97 per cent. alcohol, and afterwards saturated with oil of cloves, the embryos are placed in a watch-glass containing a melted mixture of chloroform and paraffine in equal parts, in which they may remain twenty or thirty minutes at a temperature not above 150° F. When saturation is complete the eggs have the same appearance in the melted mixture as in alcohol.

b. From the above they are transferred to another larger dish containing pure paraffine, which melts at 158° F., but which must, on no account, be allowed to boil. Here they remain for twenty to thirty minutes more.

c. The embryos are then transferred, one or two at a time, to a common slide, such as is used for mounting objects. The slide may be warmed over an alcohol lamp. A brass ring, 5 to 8 centimeters deep and 24 in diameter, is then placed on the slide around the object. This ring is then filled with melted paraffine, and the object arranged in it in the desired position with a hot needle, when the whole is left to cool.

d. After cooling the paraffine contracts within the ring, when the latter may be removed, and the discoidal block may then easily be loosened from the slide. The block may then be trimmed down with a scalpel into a shape suitable for fastening into the well in the carriage of a sledge microtome, or the block may be marked and laid away until it is wanted for use.

Fastening the block in the microtome.—This may be done by taking a hot needle and melting a cavity with it in the paraffine contained in the well of the carriage of the microtome, into which the block, with the object, is adjusted in the desired position and left till the paraffine has cooled around the block, when the operator is ready to commence cutting.

Osmic acid as a killing and hardening agent for infusorians and small embryos.—The use of osmic acid in the study of the development of *Amphiaxus*, by Hatschek, has given very good results. During their early stages the embryos of this creature are quite small, and swim about in the sea water in which they have been hatched. Hatschek killed the embryos and hardened them in the following manner: A few drops of a 1 per cent. solution of osmic acid was poured into the small vessel of sea water containing the embryos, and allowed to act only a short time. This killed the embryos and hardened them, and also afforded a ready means of collecting them, for as soon as they were dead they fell to the bottom of the vessel and were then easily picked up with a pipette, or the supernatant mixture of sea water and osmic acid was poured off and replaced with fresh sea water two or three times, so as to wash off the acid and arrest its further action. They were then transferred to absolute alcohol and finally to oil of cloves.

The embryos were embedded in wax and oil on a slide thinly coated with clove oil. A single drop of a mixture of wax and oil (beeswax and oil equal parts) is dropped on the embryo, when its position may be arranged on the slide by turning the congealed drop of wax. He covered the whole slide, which was greasy with oil, with a coating of the melted wax and oil. The position of the embryo is then carefully marked with needle scratches. The mass is then slipped off of the slide and covered on the opposite side with another coat of wax and oil. To prevent the two halves of wax from separating, it is a good practice to pass a hot needle through both at different points in order to bind them together. The sections are then cut by hand, which, judging from Hatschek's figures, was very successfully done.

M. Adrien Certes has used osmic acid in order to kill and precipitate infusorians and other minute organisms found in fresh and salt water with gratifying results. One cubic centimeter of a 1 per cent. solution of osmic acid he finds sufficient to kill the minute animal and vegetable organisms in 30 to 40 cubic centimeters of water, these organisms being precipitated to the bottom of the vessel and fixed in their form. The acid must not be allowed to act too long, and to prevent this an equal volume of distilled water is added to the mixture after the organisms have been killed.

In the case of some waters rich in organisms, microsopic examination of the deposit so obtained may begin after a few hours. In the case of very pure water it may be necessary to wait for twenty-four or even forty-eight hours before the supernatant liquid may be poured off and the precipitated organisms examined.

It affords a very ready way of killing and collecting very minute organisms from either fresh or sea water. This method may also be used to precipitate bacteria or other supposed hurtful organisms from suspected potable waters.

Henneguy's method of preparing and investigating the eggs of salmonoids.—"The ova of the *Salmonidæ* are usually employed by embryologists in the study of the development of the osseous fishes. It is difficult to examine them in the fresh state, either whole or by transmitted light, on account of the thickness of their envelopes, or after opening them, in consequence of the small consistency of the germ, especially at the commencement of segmentation. Chromic acid, the reagent most frequently employed to harden these ova, readily alters the young cells, and deforms the embryos by compressing them between the unextensible envelope of the ovum and the solidified vitelline mass. For the last two years I have employed in the laboratory of Comparative Embryology of the Collége de France a process which enables us to extract the germs and embryos from the ova of trout and salmon with the greatest facility, and without causing them to undergo the least alteration.

"I place the ovum for a few minutes in a 1 per cent. solution of osmic acid until it has acquired a light brown color, then in a small vessel containing Müller's fluid, and I open it with a fine pair of scissors in the midst of this liquid. The central vitelline mass, which is coagulated immediately on contact with water, dissolves, on the contrary, in the Müller's fluid, while the solidified germ and cortical layer may be extracted from the ovum and examined upon a glass plate.

"By treating the germ with a solution of methyle green and then with glycerine I have been able to observe in the cells of segmentation the very delicate phenomena lately indicated by Auerbach, Bütschli, Strasburger, and Hertwig, and which accompany the division of the nucleus, namely, the radiate arrangement of the protoplasm at the two poles of the cell, the nuclear plate, the bundles of filaments which start from it, and the other succeeding phases.

"This proves that the treatment undergone by the ovum does not at all alter the elements of the germ.

"In order to make cross-sections of the germs and embryos thus extracted from the ovum I leave them for some days in Müller's liquid and color them with picrocarminate of ammonia. After depriving them of water by treatment with alcohol of spec. grav. 0.828, and then with absolute alcohol, I put them for twenty-four hours into collodion. The embryo is then arranged upon a small slab of elder-pith soaked with alcohol, and is covered with a layer of collodion. When the collodion has arrived at a suitable consistency very thin sections may be made, including the embryo and the plate of pith, and these are to be mounted and preserved in glycerine.

"This process is applicable to all sorts of embryos which are not very thick, so that they may be colored *en masse*. It has the immense advantage of enabling one to see at what level in the embryo each section is made, to preserve each section in the midst of a transparent mass, which sustains all the parts and prevents their being damaged, as too

often happens when an including mass is employed from which the sections must be freed before mounting."

Binder's method of making permanent glycerine mountings.—Mr. Jacob Binder, of Philadelphia, commends the following simple method of mounting objects in glycerine, which may be found useful in conjunction with the preceding method of treating the eggs of salmonoids proposed by Henneguy, though it hardly seems probable that as good results can be got by the collodion method of embedding, which is recommended, as by some others.

Mr. Binder finds Bell's cement the best, and with it he draws a ring with a pencil upon the slide, which he allows to dry for twenty-four hours. Then another coat of the cement is applied on the top of the first ring with the aid of a turn-table. The mounting is then made with glycerine; the superfluous mounting material which is forced out from under the cover may then be washed off by holding the slide under a water-tap. The slide is then allowed to dry when the mounting is finished by the addition of another ring of Bell's cement around the edge of the cover, when the preparation is finished.

Mark's methods of treating the eggs of Limax.—For hardening the ova and fixing the nuclear structures this investigator used a 1 per cent. solution of osmic acid, the eggs being subsequently stained in Beale's carmine. He also used 1 to 2 per cent. solutions of acetic acid, in which the eggs were immersed for three hours or more and afterwards stained with Beale's carmine. Sections were made of eggs hardened in chromic acid.

E. Van Beneden's method of treating the ova of the rabbit.—For killing and hardening a 1 per cent. solution of osmic acid was used, when the eggs were transferred to *Müller's fluid* for two or three days, washed, and then mounted in glycerine.

Brass's method of killing Amœbiform Protozoa.—In order to cause these organisms to become comparatively quiet he recommends feeding them with pulverized organic matter; they are then very slowly killed on the slide by the use of the following solution, and while under observation beneath the cover-glass:

Chromic acid	1 part.
Platinum chloride	1 "
Acetic acid	1 "

Water, 400 to 1,000 parts.

This solution, he claims, will kill monera and amoebæ without altering their organization. Osmic acid, he asserts, produces dendritic appearances in the plasma of such organisms which are abnormal to them. With this re-agent he has obtained evidence of a nuclear body in some of the Monera.

Brass also thinks that turpentine and paraffin, when used to saturate an object to fit it to be cut into sections, also produces abnormal alterations in the tissues, and he recommends treating a tissue which is to be

sectionized as follows: From absolute alcohol it is transferred to oil of cloves or lavender, and then to pure paraffine, brought just a very little above the melting point.

C. Weigert's rapid method of hardening the spinal cord.—*Müller's fluid* hardens the spinal cord in about eight weeks at ordinary temperatures, but this may be accomplished eight to ten days if the hardening is done in a warm chamber or oven kept at about 120° F. While this is in progress camphor water should be added to prevent the development of putrefactive organisms.

The hardening may be still more rapidly done if *Erlick's fluid* is used. This consists of—

Potassium bichromate	2½ per cent.
Copper sulphate	½ "

With the aid of heat this hardens the spinal cord in four days, without heat in eight to ten days.

The sections are stained with *acid fuchsin*,* which is used as follows: The sections, not to exceed .025 mm. in thickness, are placed for one hour in a saturated solution of *acid fuchsin*, but the staining is greatly modified by the subsequent treatment, as the diffusely stained sections are next transferred to a large watch-glass and washed in water. They are then transferred to a third watch-glass and washed in the following solution:

One hundred cubic centimeters of absolute alcohol.
One gram of caustic potash.

This is allowed to stand for twenty-four hours, until the alcohol is saturated with the alkali. Ten cubic centimeters of this mixture are added to every 100 cubic centimeters of absolute alcohol, and in this mixture the colored sections are washed. This washing out process is the most important thing in the application of the method. As soon as the section is transferred to the alkaline alcohol on a spatula a cloud of the red coloring matter is set free. The section is then gently shaken, and as soon as the limits of the *gray matter* are defined it is transferred to a large watch-glass full of clean water. This last wash must contain no trace of acids; the traces of alkaline alcohol adhering to the spatula will do no harm, and the section must be washed in it till no more clouds of color are given off. It is then transferred to a fifth wash of clean water, when the operator should notice if the gray portions are the lightest. If this is the case and the section is still red the process has been successful. If the section is too pale it must be restained; or if the gray substance is not differentiated by a paler tinge it must be returned to the alkaline alcohol and then again washed in clean water twice in succession. The sections then dehydrated and treated in the usual way with clove oil and mounted in Canada balsam. Sections which have been embedded in celloidin should be treated with xylol instead of oil of cloves, and

* Fuchsin S. No. 130, made in the Baden Aniline and Soda Manufactory, may be obtained in small quantities from Dr. Grübler, Leipzig, 17 Dufour strasse.

these in order to be completely dehydrated must be transferred successively to two baths of absolute alcohol.

This method of staining sections of the nervous system is said to give results much superior to carmine, the anilines, or gold chloride, and to differentiate the fibers of the gray matter better than any other dye.

Embedding in celloidin.—Whitman, in the American Naturalist for October, 1883, describes the method as follows: "Very elegant results may also be obtained by an embedding mass originally invented by Duval and recently much improved by Merkel and Schiefferdecker.* This is collodion, or, preferably, a solution of so-called *celloidin*. If this substance cannot in general be cut to such extreme delicacy as the albuminous mass just described, it has a great advantage in being extremely pellucid. The original communication of the last-named author is easily accessible, so that Professor Thoma considers it superfluous to give a detailed account of it, but adds a few remarks on his own experience with it.

"According to the formula of Schiefferdecker, the embedding fluid consists of concentrated solution of celloidin in a mixture of equal parts of absolute alcohol and ether. The specimen is soaked successively in absolute alcohol and ether, and in the embedding fluid. This requires at least several days. After this time the embedding proper may be undertaken, and for this we have the choice of two methods.

"The even surface of a cork is covered with a thick solution of celloidin, so as to form by evaporation a strong collodion membrane on the cork. Upon this is put the specimen, covered layer by layer with fresh quantities of the solution of celloidin, each being allowed to dry only partially. When the object is thoroughly covered we immerse it in alcohol of 0.842 specific gravity. In twenty-four hours the whole is ready for cutting.

"The other method makes use of little paper boxes for the embedding. The specimen soaked in celloidin solution is fixed in the box by pins, the box filled with celloidin. The preparation is then placed on a flat piece of glass and covered with a glass cover which does not exactly fit the glass plate. In a few days the ether will have evaporated gently and slowly from the embedding mass, and the latter will shrink a little. If necessary more celloidin solution can be poured into the paper box to fill it again. It is only necessary to moisten the surface of the first mass with a drop of ether in order to allow of a perfect junction between the old and the new layers. The preparation is again exposed to slow evaporation below the glass cover, and a few days later the embedding mass will be consolidated to an opaline body, whose consistency can well be compared to that of the albumen of a boiled egg. The walls of the paper box can now be removed, and the embedding mass placed in very dilute alcohol, which will, in a very few days, produce a proper degree of consistency to admit of cutting.

* Arch. f. Anat. u. Physiol. (Anat. Abthiel.) 1882.

"This method differs in some degree from that which Schiefferdecker gives for embedding in paper boxes. As other observers have remarked, his method frequently gives rise to a great number of air-bubbles in the embedding mass. Consequent upon the altered manipulations of Professor Thoma, we have to adapt the embedded specimen to a cork for the purpose of cutting. This may be done in the following way: The even surface of the cork is covered by a thick layer of celloidin solution. This is allowed to dry up perfectly, so as to produce a hard membrane of celloidin. This is again covered with further celloidin solution. In the mean time the lower surface of the embedding mass is cut even and washed with absolute alcohol, and subsequently moistened with a drop of ether. This moist surface is adapted to the stratum of liquid celloidin on the cork, and exposed for a few minutes to the open air. After this the whole is placed in dilute alcohol, which in a few hours will unite the embedding mass solidly with the cork.

"In a great number of cases it may be regarded as a great advantage of the celloidin that it penetrates the tissues thoroughly, and yet remains pellucid, so as to be more or less invisible in the specimen. This quality can be made use of in another direction for the purpose of soaking specimens which are too brittle to be cut after hardening alone. We may make use of celloidin in a similar way to the gum arabic mentioned above. The minute, normal, and pathological anatomy of the lung in particular will derive great advantage from such a proceeding. Indeed, we are not able to get a perfect idea of the changes produced by pneumonia if we do not by this method or by the following (with paraffine) prevent the loss of a great part of the exuded substances which in this disease lie loose in the areolar cavities. The study also of micro-organisms in the lung will derive great benefit from the celloidin method, and it will be very welcome to many to know that the tissues embedded in celloidin may be stained with the different fluids, ammonio-carmine, alum-carmine, borax-carmine, hæmatoxylin, aniline colors, and various others. The reaction of acids and alkalies, particularly acetic acid and solution of potash is, moreover, not interfered with. And further, we are able to color the object before embedding with all staining fluids which are not soluble, or only little soluble, in alcohol or ether.

"After staining and cutting the sections may be mounted in glycerine and various other fluids. Mounting in Canada balsam requires, however, some precautions on account of the chemical character of the celloidin. Absolute alcohol and oil of cloves should be avoided and replaced by alcohol of 96 per cent., and by oleum origani. This is, at least the advice of Schiefferdecker, and Professor Thoma has had no occasion to be dissatisfied with the result."

The embedding mass, consisting of equal parts of chloroform and paraffine, used first by Bütschli, and which admits of subsequent embedding in pure paraffine, has given such excellent results in my hand, that

I do not see what else can be desired. The method which has given good results in the hands of the writer has already been described, and differs but little from the method commended by Brass. Sections of the most extreme thinness can be cut by its use, Bütschli having succeeded, with small specimens, in getting sections measuring only .002^{mm} or about $\frac{1}{12500}$ of an inch in thickness.

Combined killing, staining, and preservative agents.—To this category we may assign such combinations as ammonio-picro-carmine, borax-picro-carmine, and picric acid combined with nigrosin prepared according to the formula of Pfitzer. The preparation of ammonio-picro-carmine is attended with a good deal of trouble and takes a great deal of time and attention if some of the formulæ which have been proposed are followed in its preparation.

The readiest way of preparing a picro-carmine, I find, is to have a stock solution of borax-carmine on hand which may be poured into a saturated solution of picric acid in sufficient quantity to give a deep orange-red mixture which may then even be combined with a small percentage of alcohol. In this way we obtain a staining mixture which dyes small objects, such as embryos, with two colors in different parts, and is also a temporary preservative, killing, and hardening mixture. The objects after a day or two are removed from this mixture and put into 30 to 40 per cent., and finally into 70 per cent., alcohol.

Pfitzer's mixture of picric acid and nigrosin has been commended in botanical research; but it appears probable from a little experience which I have had with it that it will be useful in animal histology. A few drops of a watery solution of nigrosin are mixed with a saturated solution of picric acid; this mixture has an olive green color; it kills quickly and stains the granules and nuclei beautifully, imparting to them a tint somewhat similar to that produced by hæmatoxylin.

Fixing sections upon the slide preparatory to mounting.—This I find may be very easily done by the aid of Schällibaum's mixture of oil of cloves and collodion.

Collodion	1 volume.
Oil of cloves	3 to 4 volumes.

The slides are thinly painted with this mixture over the center where the sections are to be placed with a perfectly clean camel's-hair pencil. The sections which are cut by the dry method are lifted from the upper side of the section knife as fast as cut, and laid on the slide in serial order. If a section stretcher or flattener is used on the knife the sections may be lifted off in short ribbons consisting of several consecutive sections sticking together, edge to edge. After the sections have been neatly arranged in successive rows, and in serial order from left to right, with the aid of a needle, the slide may be gently warmed over an alcohol lamp, when the paraffine will melt and let the sections drop down and sink into the film of collodion and clove oil. By warming the slide

for half a minute or more the clove oil is mostly vaporized or driven to the edges of the slide and around the border of the area which is occupied by the sections. When this is the case the sections will usually be found to be fixed. Then, before the slide has cooled very much, two or three drops of turpentine are poured upon the sections. The turpentine is warmed by the slide, and the paraffine from the sections is immediately dissolved away. Turpentine is again dropped on the sections and the slide turned on its edge and drained to wash away all that remains of the paraffine surrounding and included by the sections. Before the turpentine has quite dried upon the slide the mounting is done in Canada balsam dissolved in benzole. The balsam should be thin enough to run readily under a long cover-glass, and under which as many as one hundred and fifty sections may be mounted without getting any air bubbles included.

Such serial preparations enable the embryological investigator to study the morphology of embryos or small objects with the greatest ease and certainty, because none of the viscera or organs of even the smallest embryos are displaced or shoved out of their normal positions to the slightest degree in the sections if the object has been properly embedded and the process of mounting conducted with the proper care.

It was my intention at first to give the formulæ for the preparation and use of the most approved staining fluids, but the recipes for compounding these are accessible in a number of hand-books on microscopical technology, while Mr. Whitman has already given a very full account of those used with the best success in the zoological station at Naples, in his paper on methods, from which I have already drawn so largely, the title and place of publication of which I have given in the first portion of this paper. Those staining reagents which are given here are mostly such as are used in combination with some killing or preservative agent.

The principal object of this paper is to afford directions to collectors desiring to preserve the embryos of the lower vertebrates, fishes, and amphibians in such a condition as will enable the investigator to use them in his researches. As ordinarily preserved in alcohol such objects are next to worthless, either for figuring or dissection, as well as totally useless for microscopic preparations.

XIX.—A REPORT TO THE UNITED STATES CENTENNIAL COMMISSION UPON THE PRINCIPAL AQUARIUMS ABROAD IN 1873.

By William P. Blake,

[Member of the United States Centennial Commission and agent of the Commission at the Vienna Exhibition, 1873.]

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The importance of having an aquarium connected with our exhibition was brought to our attention at an early date by the communication of Professor Baird, United States Fish Commissioner, who wrote: "I would respectfully call the attention of the commissioners to the propriety of taking steps for establishing an aquarium as part of the exhibition at the coming Centennial. You will observe the great success of these establishments which have been erected at Berlin, Hamburg, Naples, Brighton, London, &c., and the movements looking towards the erection of others at Manchester, Birmingham, &c." [Letter to the Executive Commissioner, November, 1872, Jour. Appendix, p. 88.]

Much attention has been given abroad to the construction of marine aquariums on a large scale in connection with exhibitions. One was added to the Paris Exhibition in 1867, and at Vienna, last year, a new one was opened adjoining the Exhibition on the Prater. At Sydenham, the attractions of the Crystal Palace have been greatly increased by the aquarium constructed by an independent stock company.

Such aquariums are permanently attractive and increase in popular interest from year to year, and it is found that if properly constructed and managed they are financially successful. Indeed their success has been beyond the most sanguine anticipations, and it results that aquariums have been established and projected at several points independently of exhibitions, notably at Brighton, Scarborough, and Liverpool.

When combined, as they advantageously are, with reading rooms, conservatories, promenades, concert halls, and places for refreshment, they become places of popular resort, especially in the evenings, and they exert a most salutary influence upon the mass of the people. Indeed they are real blessings to the large class of persons, in manufacturing cities especially, without attractions at home, who would otherwise spend their evenings at the drinking saloons, at cheap theaters, or in vicious wandering through the streets.

Aquariums are particularly attractive and beneficial to the young, cultivating habits of close observation, acquainting them with various and little-known forms of life, the forms and habits of fishes, and encouraging the study of natural objects generally. They may also be made to contribute largely to pisciculture generally, promoting our knowledge of the art of fish-breeding and stocking of our waters with food-fishes.

The outlay for such undertakings, compared with the results, is moderate, and the expense of maintenance is very small. Within certain limits, modified of course by the conditions of the locality, the population, &c., the largest and most liberally projected succeed best. The annual cash profit ranges from 6 to 30 per cent. on the outlay, and the value of the property and the income are constantly increasing.

Fairmount Park has great natural advantages for the construction of an aquarium, not only of fresh but of sea water, and the favorable opportunity to establish one there in connection with the Exhibition in 1876 should not be lost sight of. It should be independent of the Exhibition in its organization, but might be tributary to its success while deriving great advantages from it.

I was impressed while abroad with the importance of this subject in connection with the work of the Commission, and therefore took some pains to obtain the information presented in the following notes.

My acknowledgments are especially due to Mr. Birch, engineer of the aquarium at Brighton and at Scarborough; to Mr. Theodore L. Witt, engineer of the Vienna Aquarium; and to Mr. G. Fuberi at Berlin.

VIENNA AQUARIUM.

The Vienna Aquarium, located near the Exhibition, was completed during the summer, and added to the attractions of the Prater. It was independent of the Exhibition, being erected by a joint stock company with Baron Albert v. Klein-Wisenberg at its head. A concession of level land was obtained from the court. An ornate building of one high story, about 200 feet long and 100 feet wide, was erected upon a plan founded on the studies made of all existing aquariums by H. Nowak and the engineer Theodore L. Witt. It is constructed of brick and stucco, and is approached by a high flight of steps. All of the exhibition tanks are upon the main floor. The outline plan annexed will

give an idea of the interior arrangement of the tanks and side rooms for alligators, &c. It is drawn to $\frac{1}{730}$ of the actual size.

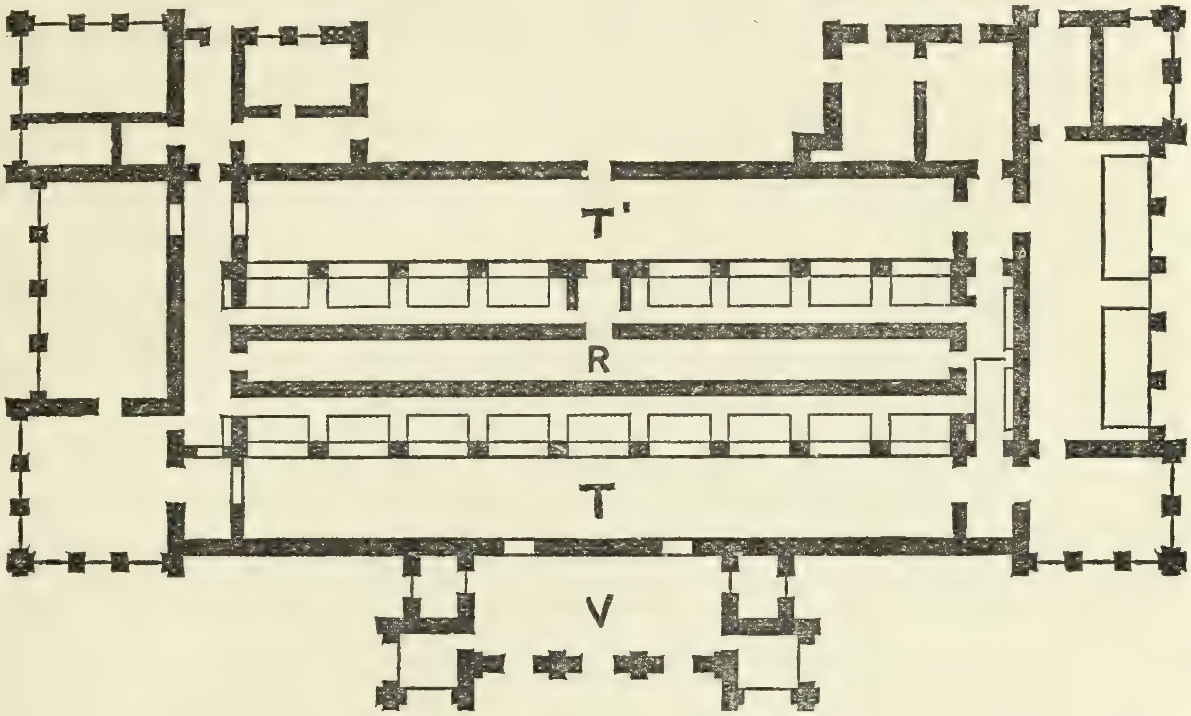

FIG. 1.—GROUND PLAN VIENNA AQUARIUM.

V.—Vestibule or entrance porch paved with tiles.
T. T.—Tanks, in two parallel lines, back to back.
R.—Reservoir between the two lines of tanks.

There are two rows of tanks, eight in each row, placed back to back, with a space between utilized for a reservoir holding a large amount of sea water. Each tank is about 9 feet long by 4 feet high and 5 feet in depth backward through the plate-glass front to the rock work. Each contains when half filled about 100 cubic feet of water. These tanks are made of brick and cement, open at the top, and accessible in the rear by a passage-way on each side of the central space R in the plan. The plate-glass fronts are $1\frac{1}{2}$ inches thick. The rooms at each end are used for large shallow basins for crocodiles, fresh-water fishes, and a collection of sea anemones.

The marine fish are brought up from Trieste, and the salt water also, by rail over the Semmering Pass. Some salt water has been successfully made. The circulation of the water is maintained by pumps driven by a small steam-engine, and the aeration is effected by a slender jet of w ter which, escaping under pressure, impinges on the surface and carries down a large amount of air into the body of the water. Another plan is to force air in fine jets from below and let it ascend through the water. Sixteen cubic meters of salt water and alike quantity of fresh water are renewed hourly. A resident zoologist has been engaged to take charge of the scientific part of the enterprise. It promises to be a pecuniary success, notwithstanding a great outlay for the building and fixtures, amounting to 250,000 florins, or about $125,000. The daily receipts amounted to about $350 for some weeks. The expense of

maintenance will be very slight, probably not over $8,000 or $10,000 annually. A naturalist is employed at Trieste in securing and forwarding specimens.

The entrance price was fixed at 50 kreutzers for adults and 20 kreutzers for children.

CRYSTAL PALACE AQUARIUM.

The aquarium is one of the added attractions to the permanent exhibition at the Crystal Palace at Sydenham, and being the property of a separate company an extra price is charged for admission. It has been very popular and is reputed to have paid 30 per cent. upon its cost annually. There are eighteen large show tanks and two rooms fitted with smaller basins or reservoirs. It is intended that the collection shall embrace the whole series of marine fauna. The cuttle fishes, the cray-fish, and the octopus attract special attention. It is located at the north end of the Palace, between the tropical department and the north rater-tower. It is below the main floor level, and is reached by a flight of steps.

THE AQUARIUM AT BRIGHTON.

This great attraction to the citizens of London and the United Kingdom and to the traveling public owes its existence to private enterprise under a joint-stock organization. It is located at the sea-side, upon land which may be said to have been reclaimed from the sea close to the chain pier immediately below the cliff, the building being protected from the waves by a strong sea-wall formed of concrete and Portland stone. It was provisionally opened at Easter, 1872, but not to the public until the following August, upon the occasion of the visit of the British Association.

The building is 715 feet in length, with an average breadth of 100 feet, and is sunk below the surface for the most part in order not to intercept the view of the water from the cliff and the line of buildings facing the beach. It was erected from the designs and under the superintendence of Mr. E. Birch. It is on the Italian style of architecture, and bricks, terra-cotta, granite, and tiles are the chief materials. Mr. Birch visited the Boulogne aquarium in 1866 and wasled to conclude that the construction of marine aquariums on a scale of magnitude hitherto unattempted was a matter eminently fitted for British enterprise. Brighton, being a place of great resort on the coast and readily accessible from London, was selected as the most feasible spot for the construction.

On entering, the visitor finds himself at the head of a broad flight of granite steps, with tiled platforms at intervals, so that the descent is rendered very gradual and easy. There are five arched portals 18 feet high, supported by decorated terra-cotta columns. On one side is the restaurant, and on the other the reading room, where the serials and daily papers can be found. For the relative positions of these rooms

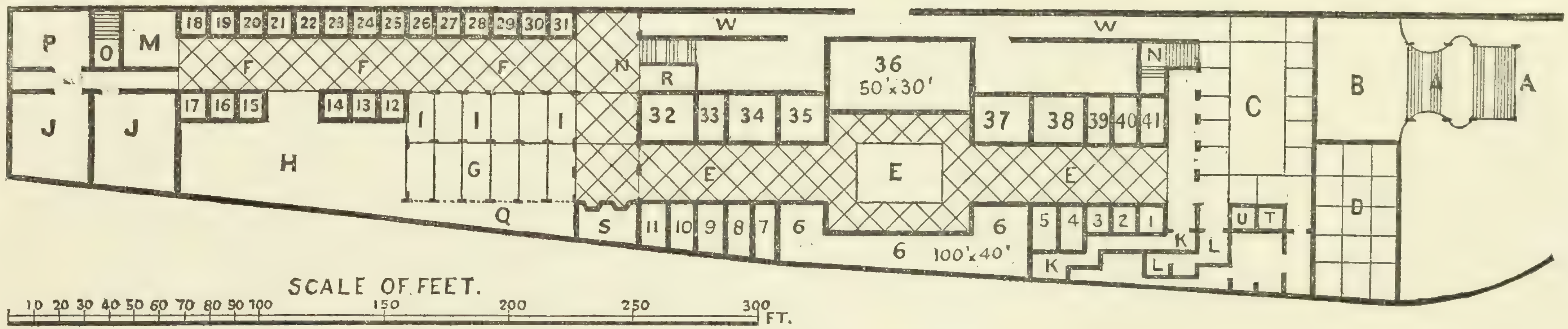

Fig. 2.—Ground Plan of the Brighton Aquarium.

A.—Steps descending from west end (20′ wide).
B.—Entrance court (60′ × 40′).
C.—Entrance hall and reading room (80′ × 45′).
D.—Restaurant and dining hall.
EEE.—Western corridor with tanks on each side.
FFF.—Eastern corridor.
G.—Conservatory.
H.—Rock-work, fernery, and cascade.
III.—Space with table tanks.
JJ.—Engine-room, stories, &c.
KK.—Lavatories.
LL.—Lavatories.
M.—Naturalists' rooms.
N.—Steps from corridors to promenade over
O.—Business and private entrance.
P.—Curator's office.
Q.—Rock-work with ponds for seal, &c.
R.—Grotto.
S.—Heating apparatus.
T.—Clerk's office.
U.—Board room.
W.—Inclines for hand chairs.

and the other parts of the building, reference may be made to the annexed plan, with scale and some of the dimensions stated. Nos. 1 to 41 indicate the tanks.

The retiring rooms and kitchen lie to the north of the hall. The longest of the three corridors extends 220 feet and is broken by a vestibule 55 by 45 feet.

The roof is groined and constructed of variegated bricks. It rests upon columns of Bath stone, polished serpentine, and Aberdeen granite. There are 21 tanks in the first two series. They increase in size from 11 by 10 feet upward, the largest measuring over 100 feet long by 40 feet wide and holding 110,000 gallons of sea water. This is the largest tank in the building and is reserved for such large marine specimens as porpoises, congers, turtles, &c. The next largest tank is 50 feet by 30 feet. The whole of the tanks, 41 in number, are numbered consecutively, commencing on one side. The glass plates for these tanks are of necessity very strong and heavy, being not less than one inch in thickness.

The salt water is taken directly from the sea by pumping and is run into reservoirs under the floors of the corridors, from which it is again pumped by the same steam-engine, and delivered to the tanks as required. The reservoirs hold 500,000 gallons of water. In the tanks the water is constantly aerated and kept in circulation by a stream of compressed air supplied to the lower part of the tanks. It is forced in by the steam-engine. This system allows the water in each tank to be heated separately, and is found in many respects preferable to the method of obtaining circulation by means of pumping. It permits circulating reservoirs to be dispensed with. The temperature of the water is kept down and the impurities are oxidized by the air.

The second corridor is about 160 feet long. One side of the eastern portion is assigned to the fresh-water animals. The offices for the curator and naturalist are beyond. These are fitted up with open tanks and every convenience for the nursing and care of the fish which require treatment before being placed in the large tanks.

The conservatory and fernery are two great additional attractions to the establishment. They are approached from the western corridor. The rock work is here remarkably well executed in imitation of ledges of red sandstone. It is all formed of chalk and cement colored red, and is so well done that few persons would for a moment question its being a natural outcrop. Ferns grow in the clefts, and on projecting tables of the rock. There is also a stream of water, broken at intervals by cascades and ponds, utilized for the seals and the larger reptilia.

In addition to the large tanks, there are numerous smaller or table tanks for the reception of some of the smaller and more rare marine animals. There is also an exhibition of the apparatus for hatching and developing trout and salmon.

The nature of the exhibition, its extent and variety, are shown by the annexed list of the tanks and contents as they were in 1873:

1. Corals, sea-anemones, sea-cucumbers, tube worms.
2. Weevers, smelts.
3. Scad or horse mackerel, young salmon.
4. Black bream, prawns.
5. Mackerel.
6. Turtles, tope, nursehound, sting ray.
7. Skate, spotted ray.
8. Silver whiting, anemones.
9. Codling.
10. Bass, seacray fish.
11. Mackerel, zoophytes.

Here intersects the conservatory with ponds for the alligators, seals, and table tanks for the smaller animals, such as anemones, corals, serpulæ, young dog-fish, tortoises, &c.

12. Perch, pope, and English pearl mussel.

13, 14. Pike, carp, tench.

15. Gudgeon, minnows, gold and silver carp.
16. Trout.

17, 18. Prussian carp and gold and silver carp, and eels.

19. Sea-horses.
20. Sun-mullet, gray mullet.
21. Halibut, brill, turbot, soles, plaice, flounders.
22. Wrasse.
23. Codling and silver whiting.
24. Eggs of dog-fish, skate, and cuttle-fish.
25. Octopus.
26. Sea-cray fish.
27. Crabs, goose barnacles.
28. Lobsters.
29. Octopus.
30. Sea bream.
31. Anemones, small star-fishes, zooplytes, whiting pout.

Here intersects the Grotto containing gold and silver carp, water lilies, and ferns.

32. Herrings, anemones, sand eels.
33. Stickle-backs, anemones, &c.
34. Conger eels.
35. Cod.
36. Picked and spotted dog-fish.
37. Rock whiting or whiting pout.
38. Spotted dog-fish, nurse, and rough-hounds.
39. Monk-fish and gray mullet.
40. Smooth hounds, sting rays.
41. Gurnard, pipe-fish, dragonets, ascidians.

This great aquarium has been a success in every way. As a paying investment it has been remarkable. The total expenditure was £80,000, about $400,000, which included cost of the land and of the sea-wall and a carriage drive and promenade. Over £25,000 have been returned in dividends. Ten per cent. was paid in 1873 and another dividend of 15 per cent. was about to be declared.

The company publishes a guide-book to the aquarium, giving all needful information to the visitor, and interesting descriptions of most of the fishes. Two distinguished naturalists, Frank Buckland and Henry Lee, are employed. I am indebted to the guide-book and to the engineeer, Mr. Birch, No 7 Wesminster Chambers, London, for the information here given beyond what could be obtained by personal examination.

SCARBOROUGH AQUARIUM.

The great success of the Brighton undertaking has induced the same parties who now hold that stock to project another aquarium upon even a greater scale at Scarborough. The work is under the direction of the same engineer, Mr. E. Birch, who showed me some of the plans. The new work will have some improvements, and will be the finest in existence. Money will be freely used for its advancement and to render it a most attractive place of resort for amusement and instruction. It is confidently expected that it will be a profitable enterprise.

AQUARIUM AT LIVERPOOL.

A new aquarium is not only to be built at Scarborough, but the city of Liverpool is also to have one on a large scale combired with a concert hall, a conservatory, a restaurant, &c. All these portions of the structure will be so arranged as to be in one unbroken line and to give a delightful promenade and place of resort. The general plan is a parallelogram, and there are to be twenty-four tanks, ranging from 6 to 70 feet in length, with a capacity of 100,000 gallons of sea-water drawn from a reservoir capable of holding four times the amount. And in the same manner as at Brighton there will be numerous table tanks and basins. Artificial rock-work ferneries, &c., constitute part of the plan, which is to be executed in the best and most liberal manner. The estimated cost is $250,000, which is to be raised by the sale of shares.

BERLIN AQUARIUM.

The aquarium at Berlin, owned by a joint stock company, founded in 1867 and opened on the 11th of May, 1869, has since been in continuous and successful operation. It is located in the heart of the city, upon the famous avenue *Unter den Linden*, so that it is not only readily reached, but is a constant attraction day and evening to those who have an hour or two at command. It occupies a building in the rear of that fronting on the street, so that the street frontage is not injured for busi-

ness purposes, the entrance being at the side and up a broad staircase through to the rear. The area occupied is 100 square rods and the structure is two stories high, but is so arranged that the distance from top to bottom appears much greater, and indeed all appearance of a building is lost, the visitor being apparently in an extensive natural grotto or cavern, with long vistas underground varied with lakes and little brooks. The semblance of natural walls of rocks and of arches worn out by the elements is admirable. The foot-paths wind about between the tanks for the fish, and are so arranged as to pass one below another and give the effect of distance. All trace of the busy city life without is lost. The sounds of traffic do not penetrate the rocky walls and there is nothing to divert the mind from the study of the habits of the wonders of marine and terrestrial life there brought together.

It has been found desirable to add some of the more remarkable and curious animals and a collection of birds to the collections of marine and fresh-water life, but these animals consist almost exclusively of such species as are seldom found in zoological gardens. The upper story or upper portion of the grotto is devoted mainly to such animals, to birds and reptiles, while the lower portions contain the fish in a series of tanks, with plate-glass fronts bordered by rock-work. The principal divisions of the interior are, the hall of serpents, the geological cavern, the aviary, the fresh-water gallery, the staircase cavern, the northern, the middle, and the southern halls.

In the hall of serpents a variety of the reptiles of Europe and other countries are displayed in suitable wall cages, among them the boas, poisonous serpents, lizards, and chameleons.

The aviary is so arranged as to appear to be in a cavern, the geological cavern, in which the stratification and other phenomena of rocks are shown. There are also basins for crocodiles and other animals. In the fresh-water gallery on the right are placed cages for birds and on the left tanks for the river and sea fishes of Europe. Apparatus for artificial fish breeding is shown along the staircase or winding descent in the cavern, and there is also a small pond for beavers at the bottom. The three large halls are devoted to the marine life. The total number of tanks and cages is not less than 150.

The number of animals, including fishes, &c., is about 15,000, of 800 species, but the number is increasing constantly, and there is more or ess fatality and constant change.

The sea-water is artificially prepared and proves to be satisfactory. About 10,000 cubic feet are required and only such portions are renewed as are spoiled or lost in the basins. It circulates constantly, and is pumped into a reservoir at an elevation of 70 feet, from which it flows to the tanks and is cleared by filtration on the way. Experience entailed successive modifications until satisfactory results were attained.

The place is very popular. It is lighted with gas and is open in the evenings. There are suitable places for resting and refreshments. The

price of entrance is equal to about 25 cents, children half-price, and there are some cheap or half-price days. The total number of visitors from May to December, 1869, was 212,540; in 1870 there were 210,056; in 1871, 215,828, and in 1872, 254,078.

The company is organized with a capital of 200,000 Prussian thalers, equivalent to about $150,000, and regular 6 per cent. dividends have been paid annually. It is understood that there is a surplus fund, and an extra dividend is expected in April, 1874.

The designs for the caverns and rock-work were executed by Mr. Leier, of Hanover, now deceased.

AQUARIUM AT THE PARIS EXPOSITION, 1867.

The aquarium at the Paris Exposition in 1867, was one of the most notable of the attractions of the garden. There was no outer display of a building, nothing but a picturesque addition to the ground in the form of the entrance to a cavern, or grotto. The semblance of a stalactitic cave was perfect. The visitor leaving the green sward and parterres of flowers without, wandered between huge stalactites, in irregular winding passages, shutting out the light of day except that which penetrated dimly through the tanks of sea-water at the sides and in the roof.

THE NAPLES AQUARIUM.

The marine aquarium recently completed at Naples is located on the Riviera, near the central point of attraction to the public. The tanks are arranged on three sides of a large oblong hall, and the light enters the water from above, as in other aquaria. A double row of smaller tanks extend along the center, and these are lighted by a central opening, or court.

The space in the building above is devoted to the naturalists' laboratory, where there are tanks and work tables sufficient to accommodate twelve zoologists. Tables are rented to representatives from the leading universities and museums of the world. Great pains have been taken to secure a full zoological library. It now includes a nearly complete set of embryological works and all the principal zoological journals. These data regarding the aquarium at Naples are condensed from correspondence of the London Athenæum.

MILL ROCK, NEW HAVEN, *May*, 1874.

XX.—NOTICE OF THE REMARKABLE MARINE FAUNA OCCUPYING THE OUTER BANKS OFF THE SOUTHERN COAST OF NEW ENGLAND, AND OF SOME ADDITIONS TO THE FAUNA OF VINEYARD SOUND.*

By A. E. Verrill.

1881.

The United States Fish Commission occupied, during the season of 1881, the station at Wood's Holl,† Mass., on Vineyard Sound, where a laboratory for its use was established in 1875.

The shallower waters of that region had been very fully explored by the Fish Commission in 1871 and 1875. Nevertheless, much was done this year toward completing the investigation of the surface fauna, which is exceedingly rich and varied at Wood's Holl. The larval forms of crustacea, annelida, echinodermata, mollusca, etc., were taken in larger numbers in the towing nets, as well as adult forms of many kinds, including, especially, numerous species of Syllidæ, many of which were new.

The special subject for investigation this year was, however, the rich fauna that was discovered in 1880, in deep water, about 75 to 120 miles off the southern coast of New England, near the edge of the Gulf Stream. A brief account of our discoveries in that region, in 1880, was published by me in the American Journal of Science (vol. xx, p. 390), with notices and descriptions of many of the mollusca and echinoderms then discovered. A more detailed account of the mollusca‡ was published by me in the Proceedings of the National Museum (vol. iii, pp. 356–409, December and January). Prof. S. I. Smith published an account of the crustacea in the same Proceedings (vol. iii, pp. 413–452, January, 1881).

In the following article some of the more interesting species, obtained in both years, are noticed. Some of these species were also dredged on the 16th of November, 1881, by Lieut. Z. L. Tanner, in a trip made to the deep water off the mouth of Chesapeake Bay, after the regular dredging operations of the season had ceased.

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* The following article is an abstract of papers published in the American Journal of Science, Vols. XXII–XXIV, 1881 and 1882.

† Formerly written "Wood's Hole," but the name was changed by order of the Postmaster-General, in 1875.

‡ Much fuller reports on the mollusca, with numerous illustrations, have more recently been published by the author in the Trans. Conn. Academy, Vols. V and VI.

As many of the species there obtained are referred to, a list of the stations is here added:

Station.	Locality.	Fathoms.	Bottom.
	N. Lat. W. Long.		
896	37° 26′ 74° 19′	56	Sand, shells.
897	37 25 74 18	157½	Sand, mud.
898	37 24 74 17	300	Mud.
899	37 22 74 29	57½	Sand.
900	37 19 74 41	31	Do.
901	37 10 75 08	18	Do.

Our dredgings this year, in deep water, were also made with the Fish Hawk, Lieut. Z. L. Tanner, commander. Mr. A. P. Chapin, of Warsaw, N. Y., made the temperature observations and records of soundings, etc.

The party immediately associated with the writer in the zoological investigations consisted of Prof. S. I. Smith and Mr. J. H. Emerton (artist), of Yale College; Dr. T. H. Bean and Mr. Richard Rathbun, of the National Museum; Mr. Sanderson Smith, of New York; Prof. L. A. Lee, of Bowdoin College; Mr. B. F. Koons, Mr. E. A. Andrews, and Mr. H. L. Bruner, graduates and special zoological students of the Sheffield Scientific School, of New Haven, and Mr. Peter Parker, of Washington. Most of these gentlemen had been associated with me in the same way in previous years.

The off-shore regions explored this year are included between north latitude 39° 40′ and 40° 22′, and between west longitude 69° 15′ and 71° 32′.

They occupy a region about 42 miles wide, north and south, and about 95 miles long, east and west, or about 105 miles along the 100-fathom line.

Series of dredgings were also made this season off Cape Cod, in Vineyard Sound, in Buzzard's Bay, and off Martha's Vineyard, between the deep-water and shallow-water localities of former years.

It is probable that the remarkable richness of the fauna in this region, both in the number of species and in the surprising abundance of the individuals of many of them, is due very largely to the unusual uniformity of the temperature enjoyed at all seasons of the year, at all those depths that are below the immediate effects of the atmospheric changes. The region under discussion is subject to the combined effects of the Gulf Stream on one side and the cold northern current on the other, together with the gradual decrease in temperature in proportion to the depth. It is, however, probable that at any given depth below 50 fathoms, the temperature is nearly the same at all seasons of the year. Moreover, there is, in this region, an active circulation of the water at all times, due to the combined currents and tides. The successive zones of depth represent successively cooler climates more strikingly here than

near the coast. The vast quantities of free-swimming animals continually brought northward by the Gulf Stream and filling the water, both at the surface and bottom, furnish an inexhaustible supply of food for many of the animals inhabiting the bottom, and probably directly or indirectly, to nearly all of them. A very large species of *Salpa*, often 5 or 6 inches long, occurs both at the surface and close to the bottom, in vast quantities. Sometimes several bushels come up in a single haul of the trawl. I have taken this same *Salpa* in very numerous instances, from the stomachs of star-fishes of many kinds, from Actiniæ of several species, etc. Pteropods also frequently occur in the stomachs of the star-fishes, while Foraminifera furnish a large part of the food of many of the mud-dwelling species of various orders.

The fishes, which are very abundant and of many species, find a wonderfully abundant supply of most excellent food in the very numerous species of crabs, shrimp, and other Crustacea, which occur in such vast quantities that not unfrequently many thousands of specimens of several species are taken in a single haul of the trawl. Cephalopods are also abundant and are eagerly devoured by the larger fishes, while others prey largely upon the numerous gastropods and bivalves.

Table of outer stations occupied in 1881, with temperatures of bottom and surface.

[The distances are measured from Gay Head light, in geographical miles. The bearings are magnetic.]

Station.	Locality.	Fathoms.	Bottom.	Date.	Temp. F.		Hour.
					Bottom.	Surface.	
	OFF MARTHA'S VINEYARD.						
917	S. ½ W. 59½ miles	44	Green mud	July 16	42°	63°	4.10 a. m.
918	S. ½ W. 61 miles	46	......do	July 16	45	63	5.33 a. m.
919	S. ½ W. 65 miles	53	......do	July 16	42.5	66	7.00 a. m.
920	S. ½ W. 68½ miles	63	......do	July 16	49	66	8.20 a. m.
921	S. ½ W. 73 miles	67	......do	July 16	52	70	9.40 a. m.
922	S. ½ W. 77 miles	67	Green mud, sand	July 16	52	72	10.57 a. m.
923	S. ½ W. 78½ miles	98	Sand	July 16	52	72	12.27 p. m.
924	S. ½ W. 83½ miles	164	......do	July 16	44.5	71	1.52 p. m.
925	S. ½ W. 86 miles	229	Sand, mud	July 16	42	71	3.35 p. m.
926	S. ½ W. 85 miles	199	......do	July 16	44	71	5.24 p. m.
935	S. by E. ½ E. 106½ miles	782		Aug. 4	39.5	70	8.14 a. m.
936	S. by E. ½ E. 104½ miles	716	Mud	Aug. 4	39.5	71	10.43 a. m.
937	S. by E. ½ E. 102 miles	661	Green sand, mud	Aug. 4	40.5	72	12.45 p. m.
938	S. by E. ½ E. 100 miles	317	......do	Aug. 4	42	72.5	2.44 p. m.
939	S. by E. ½ E. 98 miles	264	......do	Aug. 4	47	73	4.25 p. m.
940	S. by E. ½ E. 97 miles	134	Sand	Aug. 4	52	72	5.30 p. m.
941	S. by E. ½ E. 89¼ miles	77	Sand, mud	Aug. 4	52	71	7.45 p. m.
942	S. by W. ¾ W. 81½ miles	138	......do	Aug. 9	50	69	6.15 a. m.
943	S. SW. 83 miles	157	Sand, mud, shell	Aug. 9	49	70	7.10 a. m.
944	S. SW. 82 miles	128	......do	Aug. 9	51	70	8.27 a. m.
945	S. by W. ¾ W. 84½ miles	207	Green mud, sand	Aug. 9	44	71	12.05 p. m.
946	S. by W. ¾ W. 87½ miles	247	......do	Aug. 9	47	71	2.00 p. m.
947	S. by W. ¾ W. 89 miles	319	Sand, mud	Aug. 9	44	70	4.00 p. m.
949	S. 79½ miles	100	Yellow mud	Aug. 23	52	66	4.20 a. m.
950	S. 75 miles	71	Sand, shell, mud	Aug. 23	52	65	5.50 a. m.
951	S. 85 miles	225	Mud	Aug. 23	41	67.5	9.40 a. m.
952	S. ¼ E. 87½ miles	396	Yellow mud, sand	Aug. 23	40	68	11.28 a. m.
953	S. ½ E. 91½ miles	724	Mud	Aug. 23	39.5	68	2.30 p. m.
954	S. ½ E. 91 miles	651	Sand, mud	Aug. 23	39.5	68	4.50 p. m.
994	S. SW. ¼ W. 104½ miles	368	Mud	Sept. 8	40.5	68	4.50 a. m.
995	S. SW. ¼ W. 104¼ miles	358	Yellow mud, sand	Sept. 8	40.5	68	6.32 a. m.
996	S. SW. ¼ W. 104 miles	346	......do	Sept. 8	40	67.5	7.35 a. m.
997	S. SW. ¼ W. 103½ miles	335	Yellow mud	Sept. 8	40	67.5	9.03 a. m.
998	S. SW. ¼ W. 102½ miles	302	Gravel, mud	Sept. 8	40	68	10.34 a. m.
999	S. SW. ¼ W. 100 miles	266	......do	Sept. 8	....	68	11.48 a. m.
1025	S. SW. ¼ W. 95 miles	216	......do	Sept. 8	45	69	1.05 p. m.
1026	S. SW. ¼ W. 93½ miles	182	......do	Sept. 8	47.5	69	2.55 p. m.

Table of outer stations occupied in 1881, *with temperatures of bottom and surface*—Cont'd.

Station.	Locality.	Fathoms.	Bottom.	Date.	Temp. F.		Hour.
					Bottom.	Surface.	
	OFF MARTHA'S VINEYARD—Continued.						
1027	S. SE. ¾ E. 105½ miles	93	Fine sand	Sept. 14	48½	65	7.23 a. m.
1028	S. SE. ¾ E. 108½ miles	410	Yellow mud	Sept. 14	41	66	9.01 a. m.
1029	S. SE. ¾ E. 109½ miles	458	......do	Sept. 14	40	68	12.13 p. m.
1030	S. SE. ⅞ E. 108½ miles	337	......do	Sept. 14	41	66	1.52 p. m.
1031	S. SE. ⅝ E. 107½ miles	255	......do	Sept. 14	46	65	2.54 p. m.
1032	S. SE. ½ E. 107 miles	208	......do	Sept. 14	46	65	4.00 p. m.
1033	S. SE. ½ E. 106 miles	183	Sand, gravel	Sept. 14	....	63	4.55 p. m.
1034	S. SE. ½ E. 105¼ miles	146	Sand, yellow mud	Sept. 14	46½	62	5.55 p. m.
1035	S. SE. ½ E. 103½ miles	120	Sand	Sept. 14	47	62	6.56 p. m.
1036	S. SE. ½ E. 102 miles	94	......do	Sept. 14	51	61½	7.54 p. m.

FISHES.

The fishes obtained by us are of great interest. The large number of species taken will be indicated by the list, which has been made out by Dr. T. H. Bean, who had charge of the fishes this season. (See page 339.)

The new species of fishes taken in 1880, in this region, were described by Mr. G. Brown Goode, and a list of the fifty-one species, obtained by us, was also published by him. (Proc. Nat. Mus., iii, pp. 337–467, November, 1880, and February, 1881.)

The most important of the fishes is the *Lopholatilus chamæleonticeps* Goode and Bean, or "Tile-fish" (see page 237). This is a large and handsome edible fish, first discovered on these grounds in 1879, and not yet found elsewhere. It seems to be very abundant over the whole region explored by us, in 70 to 134 fathoms. On one occasion a "long-line" or "trawl-line" was put down at station 949, in 100 fathoms, and seventy-three of these fishes were taken, weighing 541 pounds. These varied in weight from 2½ to 31 pounds. It is brownish gray, more or less covered with large bright yellow spots. The *Peristedium miniatum* Goode, is a very curious and handsomely colored fish, often bright red throughout. The several species of "hake" (*Phycis*) are common, as well as the "whiting" (*Merlucius bilinearis*). Large specimens of the "goose-fish" or "angler" are often taken in the trawl, in as much as 250 fathoms.

MOLLUSCA.

Most of the mollusca recorded in my papers of last year were again obtained this season, and often in larger numbers. A complete list will be published in a future paper. At the present time I shall refer only to some of the more important ones, and to some of those that were additions to the fauna.

Of the Cephalopods, the following species were taken:

Lestoteuthis Fabricii Verrill. = *Gonatus Fabricii* Steenstrup.

Station 953; 715 fathoms; one large and perfect male specimen. Station 1031; 255 fathoms; one young specimen.

The former is the form recently figured by Steenstrup, under the above name, and considered by him the adult of *Gonatus amœnus.*

Ommastrephes illecebrosus Verrill.

Stations 918, 919, 923–925, 939, 940, 949, 1025, 1033; 45–258 fathoms.

Desmoteuthis tenera Verrill.

Station 952; 388 fathoms. Two specimens.

Rossia sublevis Verrill.

Stations 924, 925, 939, 945–947, 951, 952, 997, 1025, 1026, 1028, 1029, 1032, 1033; 106–388 fathoms. Some of the specimens recently obtained agree more nearly with *R. glaucopis* Lov., as figured by G. O. Sars, than any seen before. It may prove to be identical.

Heteroteuthis tenera Verrill.

Stations 918, 919, 920, 921, 922, 940, 944, 949, 950, 1026, 1027; 45–182 fathoms. Eggs of this species were taken at stations 922, 940, 949, and in several localities in 1880. They are nearly round, ivory-white or pearly, attached to shells, etc., by one side, in groups, or scattered. On the upper side there is a small conical eminence.

Stoloteuthis leucoptera Verrill.

Stations 947, 952, 998, 989, 1026 (3 juv.); 182–388 fathoms.

Octopus Bairdii Verrill.

Stations 925, 939, 945–947, 951, 952, 994, 997, 998, 1025, 1026, 1028, 1033, 1035; 103–388 fathoms.

Alloposus mollis Verrill.

Stations 937, 938, 952, 953, 994; 310–715 fathoms. Two very large females were taken; one at station 937, in 506 fathoms; the other at 994, in 368 fathoms. The former weighed over 20 pounds. Length from end of body to tip of 1st pair of arms, 31 inches; of 2d pair, 32; of 3d pair, 28; of 4th pair, 28; length of mantle beneath, 7; beak to end of 4th pair of arms, 22; breadth of body, 8.5; breadth of head, 11; diameter of eye, 2.5; of largest suckers, .38.

The only additional Pteropod taken this year is *Triptera columnella* (Rang), from Station 947. Among the Gastropods there are a considerable number of species not obtained last year. Perhaps the most remarkable discovery in this group is a fine typical species of *Dolium* (*D. Bairdii*) taken alive in 202 fathoms. This genus is almost exclusively tropical in its distribution. On our coast, *D. galea* extends northward to North Carolina. This southern genus, with a large *Marginella*, *M. borealis* V., taken both this year (Station 949) and last, *Solarium boreale* V., *Avicula hirundo*, and various other genera, more commonly

found in southern waters, are curiously associated, in this region, with genera and species which have hitherto been regarded as exclusively northern or even Arctic, many of them having been first discovered in the waters of Greenland, Spitzbergen, Northern Norway, Jan Mayen Land, etc.

Among the northern species which had not been found previously south of Cape Cod, the following were dredged: *Trophon clathratus*, 972, 976; *Acirsa costulata* (=*borealis*), 965; *Amauropsis Islandica* (=*helicoides*); *Margarita cinerea*, 981; *Cylichna Gouldii*, 973; *Odostomia* (*Menestho*) *striatula*, 980.

Dolium Bairdii Verrill and Smith.

A moderately large species, having nearly the form of *D. perdix* and *D. zonatum*. Male. Shell broad ovate, with seven broadly rounded whorls; spire elevated, apex acute; nuclear whorls about three, smooth; suture impressed, but not deep, nor channeled; the last whorl is somewhat flattened (perhaps abnormally) below the suture, for some distance, corresponding to an inward flexure of the outer lip. Aperture elongated, irregularly ovate; outer lip regularly rounded, except for a short distance posteriorly, where it is slightly incurved, its edge is excurved, acute externally, distinctly but not prominently crenulated within, except posteriorly, where a posterior canal is slightly indicated; columella straight; canal short and broad. The sculpture is peculiar: it consists of numerous (about 40 on the last whorl) rather prominent, squarish, clearly defined revolving ribs, less than 1^{mm} broad, separated by interspaces of about the same breadth, in which there is usually one small narrow rib, alternating with the larger ones; sometimes there are two or more small ones. The whole surface, both of ribs and interspaces, is covered with fine and regular transverse, raised lines. The surface is covered with a very thin pale olive-yellow epidermis, easily deciduous when dry. Color white, except that the larger ribs are alternately light brown and white, and the apex, consisting of about three smooth nuclear whorls, is dark brown. Length, 68^{mm}; breadth, 56^{mm}; length of aperture, 53^{mm}.

The animal is well preserved. Proboscis blackish, exserted about 20^{mm}, thick (8^{mm}) and clavate at the end, which is surrounded by a sort of collar, with a finely wrinkled or crenulated, white edge. Head large, with a prominent rounded lobe in front. Tentacles large, elongated (10^{mm}), stout, tapering, obtuse. Eyes small, black, on distinct but slightly raised tubercles at the outer base of the tentacles. Head, tentacles, and siphon-tube dull brown. Penis very large (50^{mm} long, 12^{mm} broad), twisted and thickened at base, flattened distally, terminating in a slightly prominent obtuse lobe at the tip; a well-marked groove runs along the posterior edge to the tip.

Off Martha's Vineyard, station 945, 202 fathoms. Station 1036, 94 fathoms; one young specimen and large fragments.

Pleurotoma (*Bela*) *limacina* Dall. (*Daphnella ?*)

Bulletin Mus. Comp. Zool., ix, p. 55, 1881.

Four living specimens of this elegant shell were taken at station 994; 368 fathoms. Gulf of Mexico, 447–805 fathoms (Dall). This is not a true *Bela*, for it has no operculum; eyes minute.

Capulus hungaricus (Linné).

Two living specimens were obtained, which appear to belong to this species. They are more delicate and have somewhat finer and more regular radiating ribs than the ordinary European form. It has not been recorded before from our coast.

Stations 922, 1029; 69 and 458 fathoms.

Fiona nobilis Alder and Han.

British Nud. Moll., Æolidæ, Fam. 3, pl. 38 A.

A large and handsome *Fiona*, apparently this species, was found in two instances, in large numbers, on pieces of floating timber, among Anatifers, at stations 935 and 995. They were kept in confinement several days and laid numerous clusters of eggs. These are in the form of a broad ribbon, spirally coiled in about one and a half turns, so as to form a bell-shaped or cup-shaped form, and attached by a slender pedicel, so as to hang from the under side of objects. Alder and Hancock recorded its occurrence, in a single instance, at Falmouth, England.

Issa ramosa Verrill and Emerton.

Body elevated, convex above, elongated, oblong, sides nearly parallel along the middle; foot well-developed, as broad as the body. Dorsal tentacles thick, clavate, obtuse, with numerous lamellæ; sheath scarcely raised. Back and sides with numerous small, simple papillæ. Along the lateral margins of the back there is a carina, with a row of large, much branched papillæ, alternating with much smaller ones; of the large ones there are about six on each side, the most anterior are below the dorsal tentacles; two on each side are posterior to the gills, the last ones largest; a row of similar but smaller processes extends below the tentacles and around the front margin.

Gills five, arborescently branched. Color, pale yellow. The dorsal tentacles darker.

The radula is quite different from that of *I. lacera* and *Triopa claviger*. The median area is wide, with two rows of thin, transversely oblong plates; there are three rows of large, nearly equal teeth on each side, with the tips strongly incurved, obtuse; the innermost tooth has a small lobe on the middle of the inner edge: these are followed by about seventeen or eighteen smaller, oblong plates, with slightly emarginate anterior ends; these gradually decrease in size toward the margins of the radula.

Stations 940, 949; 130 and 100 fathoms.

In form this resembles *I. lacera*, but is easily distinguished by the branched appendages along the sides.

Of the Lamellibranchiata some very interesting new forms occurred. The most important of these are species of *Pholadomya*, *Mytilimeria*, and *Diplodonta*—three genera not before found on this coast. The *Pholadomya* is more related to certain fossil forms than to any of the few described living species. The genus *Mytilimeria* has hitherto had very few living representatives, and none of them resemble our very singular species.

Among the northern forms, not previously found south of Cape Cod, are the following: *Mya truncata*; *Spisula ovalis* (975, 976, 981); *Leda tenuisulcata* (973); *Nucula tenuis*.

Pholadomya arata Verrill and Smith.

Shell triangular, short, wedge-shaped, posterior end angular, somewhat produced, obtuse; anterior end very short and abruptly truncated, clearly defined by a carina extending from the beak to the outer margin; anterior to the carina there is a broad concave furrow, which bounds the slightly convex central area of the front end; the greater part of the sides of the shell is covered with deep, rather wide, concave furrows, separated by elevated, sharp-edged ribs; the furrows vary in width and decrease posteriorly; a small portion, near the tip of the posterior end is covered only by slight ribs. The surface between the ribs is finely granulated. When the thin superficial layer is removed the surface is pearly. The umbos are prominent, strongly incurved, nearly or quite in contact. The hinge in the right valve consists of a small, slightly prominent lamella, running back as a low ridge, and separated from the margin of the shell anteriorly, and from the cartilage-lamina posteriorly, by a narrow groove; the cartilage-pit is long, running forward under the beak as a narrow furrow; it is bounded internally by a prominent lamella. Length, 36^{mm}; height, 29^{mm}; breadth, 26^{mm}.

Stations 940, 949, 950; 69 to 130 fathoms.

Three specimens, all dead, but one is very fresh.

Mytilimeria flexuosa Verrill and Smith.

Shell obliquely cordate, short, higher than long, very swollen, the anterior end rather shorter than the posterior; umbos very prominent, beaks much incurved, pointed and turned forward, with a small, deep concavity just under and in front of them. The outline and surface of the shell is very flexuous, owing to the broad, deep grooves and elevated ribs which divide the surface into several areas. The most prominent rib is very high and rounded, and runs from the beak to the extreme ventral margin, inclining somewhat forward; in front of this the anterior area is flattened with a wide, shallow, concave groove or undulation in the middle, and others less marked; the front edge is broadly rounded, slightly undulated below. The middle area is very elevated, and forms more than a third of the shell; it is flattened or slightly

concave in the middle, and undulated by several faint broad ribs; it recedes posteriorly, and a broad, concave furrow separates it from the small posterior area, which is without ribs, and has a prominent rounded edge. The surface is finely granulated, lines of growth evident. The interior is pearly, angulated by a deep groove, corresponding to the largest external rib. The dorsal hinge-line is nearly straight posteriorly, and strongly incurved anteriorly, in the right valve it projects inward, but not in the left; in the right valve there is a small rounded tubercle, a little back of the beak; from below this a short rib-like process runs back below the deep, partially internal cartilage-pit, which extends forward and upward under the beak as a narrow furrow. Anterior muscular scar deep; posterior one larger, ovate, less distinct; sinus small. Length, 25^{mm}; height, 26^{mm}; breadth from side to side, 22^{mm}.

Station 947; 312 fathoms. One pair of fresh valves, dead.

This and the preceding were both taken by means of the "rake-dredge."

Diplodonta turgida Verrill and Smith.

Shell large for the genus, round-ovate, a little longer than high, very swollen; the two ends nearly equally rounded, the anterior a little narrower; ventral edge broadly and regularly rounded; beaks nearly central, somewhat forward of the middle, strongly curved inward and forward, acute. Surface without sculpture, smooth except for the evident lines of growth. In the right valve there are, opposite the beak, two nearly equal, stout, sharp teeth, separated by a space of about the same width; back of these, and partly joined at base to the posterior one, there is a much larger, broad, stout, obtuse tooth, with a groove on its dorsal side; external cartilage-groove and its lamella are long and narrow, curved. Length, 29^{mm}; height (umbos to ventral edge), 25^{mm}; breadth, 23^{mm}.

Station 950; 69 fathoms. One right valve.

1882.

During the summer of 1882 the headquarters of the United States Fish Commission were at Wood's Holl, Mass. The organization of the party was nearly the same as last year.* The special object this year

*The scientific party associated with the writer in carrying on the dredging operations and making the collections this year consisted of Mr. Richard Rathbun, Mr. Sanderson Smith, Mr. J. H. Emerton (as artist), Prof. L. R. Lee, Mr. B. F. Koons, Mr H. L. Bruner, Prof. Edwin Linton. Prof. S. I. Smith was with us for a few days. Mr. Peter Parker and R. H. Miner, midshipmen, U. S. N., took charge of the fishes, John B. Blish, midshipman, U. S. N., kept the records of soundings and temperatures, and Capt. H. C. Chester had charge of the dredging apparatus, as in previous years. The dredgings were all made by the Fish Hawk, commanded by Lieut. Z. L. Tanner, U. S. N., as during the two previous years. The writer, as usual, had general charge of these explorations, and of the investigation of the invertebrate fauna.

was to continue the exploration of the sea-bottom and its fauna beneath the edge of the Gulf Stream, which had been so successfully carried on during the two previous seasons. Owing to the unusual delay of the Government appropriations our work was delayed about a month, in the best part of the season, for we could not begin our dredging until August. Unfavorable weather and other causes afterward prevented us from making more than five trips to the Gulf Stream slope this year; but these were very successful.

One trip, occupying three days, was also made to the region east of Cape Cod. On this trip very cold bottom-water was found at moderate depths. It extended southward the known range of a number of northern species, previously unknown on this part of the coast, but did not reveal any new forms. Among the species of most interest taken on this occasion are the following: Several examples of *Urticina multicornis* V. (of which only one specimen was known previously), 55 to 90 fathoms; *Porania spinulosa* V., large, 90 fathoms, station 1088; *Solaster endeca* F., many, large and small, 32 to 90 fathoms; *Hippasteria phrygiana* Ag., several, large, 34 to 90 fathoms; *Astrophyton Agassizii* St., many, 55 to 61 fathoms, off Chatham, stations 1078, 1079; *Pentacta frondosa*, large, 34 to 37 fathoms; *Pandalus borealis*, 90 to 110 fathoms; *Geryon quinquedens*, 110 fathoms; *Balanus hameri*, 33 fathoms; *Rossia Hyatti*, several, large, 44 to 90 fathoms.

Of the five Gulf Stream trips one was made southeastward from Nantucket, farther east than any of those of 1880 and 1881, while another was made to the region about 100 miles south of the eastern end of Long Island, farther west than any of the former ones; the other three were in the intermediate region off Martha's Vineyard. Our dredgings in this region, therefore, now cover a belt about 150 miles, east and west, mostly between the 100 and 600 fathom lines. The total number of successful hauls made along this belt, in more than 100 fathoms, is now over one hundred. These have nearly all been made with the large, improved trawls; a few have also been made with a large rake-dredge. Probably no other part of the ocean-basin, in similar depths, has been more fully examined than this region.

The total number of species of Invertebrata, already on our lists of the fauna of this belt, is about 675. This number includes neither the Foraminifera, nor the Entomostraca, which are numerous, and but few of the sponges. Probably the total list of Invertebrata, already obtained, when completed will include not less than 800 species.* Of these less than one-half were known on our coast before 1880. Of fishes, there are, perhaps, 75 species. Of the whole number, already determined, about 275 are Mollusca, including 20 Cephalopoda; 95 are Crustacea; 60 are Echinodermata; 35 are Anthozoa; 75 are Annelida.

The steamer Fish Hawk, with which we have explored this region

* Subsequent explorations of this region, up to the end of 1883, have nearly doubled the numbers here given.—A. E. V.

during the past three seasons, was built particularly for use in the hatching of shad eggs, in the mouths of shallow rivers, and is, therefore, not adapted for service at sea, unless in very fine weather. A much larger steamer, the Albatross, of 1,000 tons, has been built for the use of the Fish Commission, and fitted up expressly for deep-sea service, for which she is in every respect well adapted, having the best equipment possible for all such investigations, and at all depths. The examination of the bottom beyond the depth of about 600 fathoms was therefore deferred by us till the completion of the Albatross. Nevertheless, the apparatus that we have used on the Fish Hawk has been better, in some respects, than most other vessels engaged in such work have had, whether American or foreign. This year several new improvements were made, especially in the deep-sea thermometers. New forms of traps for capturing bottom animals were also devised. The "*trawl-wings*," first introduced by us in 1881, were used this year with great success, for they brought up numerous free-swimming forms, from close to the bottom, which could not otherwise have been taken. The use of steel wire for sounding, and of wire rope for dredging, enabled us to obtain a much greater number of dredgings* and temperature observations than would have been possible under the old system, adopted on the Challenger.

Of Echinoderms, nearly all of the species previously enumerated† from

*As an illustration of the rapidity with which this work has been done by employing persons skilled in the various operations and using the wire rope, reeled upon a large drum, I give here a memorandum of the time required to make a very successful haul. In 640 fathoms, at station 1124, the large trawl was put over at 4.29 p. m.; it was on the bottom at 4.44, with 830 fathoms of rope out; commenced heaving in at 5.17; it was on deck at 5.44 p. m.; total time for the haul, 1 hour 15 minutes. The net contained several barrels of specimens, including a great number and large variety of fishes, as well as of all classes of invertebrata, probably more than 150 species altogether, several of them new.

At station 1125, in 291 fathoms, the trawl was put over at 6.03 p. m.; on bottom at 6.10, with 500 fathoms of rope out; commenced heaving in at 6.32; on deck at 6.50; total time 47 minutes. This was a very good haul, but not so large as 1124. This was the seventh successful haul of the trawl made that day. All the specimens were assorted, labelled, and packed away in alcohol before 9 p. m.

The adoption of steel-wire rope, since 1880, for dredging on the Fish Hawk has greatly expedited our work. This great improvement, first used by Lieut.-Com. C. D. Sigsbee, on the Coast Survey steamer Blake, in 1877-'78, was invented by Mr. A. Agassiz, who introduced it during that cruise, and also on subsequent ones on the Blake, when commanded by Lieutenant Bartlett. Its introduction and use has been described by Mr. Agassiz in his reports, and also, in detail, by Captain Sigsbee, in his extended work on Deep-Sea Sounding and Dredging. Our arrangements on the Fish Hawk for reeling in the wire rope were unlike those on the Blake, for we used only one drum, with 1,000 fathoms of rope on it. The use of steel wire for sounding goes back to an earlier date than is commonly supposed. It was extensively tried by Lieut. J. C. Walsh, U. S. N., on the schooner Taney, in his survey of the Gulf Stream in 1849 (see Maury's Winds and Currents of the Sea, p. 56, 1851). Important improvements have since then been made in the reels for winding it in, by Sir William Thomson, Captain Sigsbee, and others.

† See American Journal of Science, 1880 to 1882.

this region and several additional ones were obtained. Among those of special interest were *Goniocidaris papillata*, 156 to 158 fathoms; *Brissopis lyrifera*, 158 to 194 fathoms; *Spatangus purpureus*, 89 to 158 fathoms; *Schizaster canaliferus*, 100 fathoms, several; *Echinus Wallisi* A. Ag., 640 fathoms; *E. gracilis*, numerous and of large size at stations 1097 and 1098, in 156 to 158 fathoms; *Phormosoma Sigsbei* A. Ag., station 1123, in about 700 fathoms,* several, both large and small, the largest 124^{mm} in diameter; *Porania grandis* V., abundant in 156 to 158 fathoms; *Odontaster hispidus* V., abundant in 89 fathoms.

Among those added to the fauna this year are a very rare *Diadema-like* sea-urchin (*Hemipedina Cubensis* A. Ag.) from 194 fathoms, previously known only from the West Indies; *Solaster Earllii* V., of which a large nine-armed specimen, bright scarlet in color, was obtained in 234 fathoms, station 1121; *Lophaster furcifer*, several from 234 and 640 fathoms; *Astrogonium granulare*, from 156 and 640 fathoms; *Astrophyton Lamarckii*, color, bright orange, several from 194 fathoms; *Asteronyx Loveni* M. & Tr., station 1123, in about 700 fathoms, on a pennatulid; color of both bright orange; *Ophioscolex*, new sp., with four arm-spines and a small tentacle-scale, 234 fathoms; *Rhizocrinus Lofotensis*, young, from 640 fathoms.

Most of the Anthozoa† of the previous years were again obtained, with some additional ones, including a remarkable new Pennatulid belonging to a new genus,‡ and two Gorgonians: *Acanthogorgia armata* V., 640 fathoms, and *Paramuricea borealis* V., from 234 fathoms; the former, when living, was bright orange; the latter was pale salmon. Of those previously taken, one of the most interesting was *Pennatula borealis*, obtained in 192, 317, and 640 fathoms. The largest one, from 317 fathoms, was 21.5 inches high, and 5.25 broad.

Of Pycnogonida, we took some large and interesting forms, including two examples of *Colossendeis colossea* Wilson, station 1123, in about 700 fathoms, of which the larger was 19.5 inches across; *C. macerrima* W.,

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* The trawl was put down at this station in 780 fathoms, but before it was taken up the depth had become 627 fathoms.

† Most of the Anthozoa obtained by us have been described and figured by the author in the Bulletin Mus. Comp. Zoology, Vol. XI, 1883. See, also, Amer. Journ. Science, 1881–'82.

‡ *Distichoptilum* Verrill.—Slender pennatulids, with an axis through the whole length, and polyps arranged alternately, in a simple row, on each side; calicles bilobed, appressed; zooids three to each polyp, one in front and one on each side of each cell; spicula abundant in the calicles, rachis, and stalk.

Distichoptilum gracile Verrill.—Long and slender, with a long stalk. Polyp-calicles rather large, rigid, closely appressed, with two sharp terminal lobes, filled with spicula, concealing the opening, and overlapping the base of the calicle in front; zooids small, not exsert, showing as small white spots at each side and in front of each polyp cell; stalk long, slender, with a long narrow bulb; color, bright orange-red, due to the spicula; end of bulb yellowish; length, 18 inches, or 456^{mm}; breadth in middle, 2^{mm}; length of stalk, 100^{mm}.

from 317 fathoms; and several of *Nymphon Strömii*, from 234 to 640 fathoms.

Crustacea* were much less abundant than in previous years, but great numbers of large shirmp, *Pandalus leptocerus* and *P. propinquus*, occurred, the latter inhabiting the deeper waters, 158 to 640 fathoms. *Cancer borealis* was frequent in 90 to 194 fathoms. Among the more interesting species were *Geryon quinquedens*, taken in considerable numbers and of large size, at stations 1140 to 1143, in 322 to 452 fathoms; *Lithodes maia*, at station 1125, in 291 fathoms; *Pentacheles sculptus* Smith, one large, at station 1140, in 374 fathoms; *Ceraphilus Agassizii* S., several times, in 291 to 640 fathoms; *Sabinea princeps* S., station 1140 and 1143, in 374 to 452 fathoms; *Boreomysis tridens*, in 351 fathoms; *Hippolyte Liljeborgii*, frequent in 144 to 640 fathoms; *Janira spinosa* Harger, in 640 fathoms; *Astacilla granulata* (Sars) H., in 291 to 640 fathoms.

Many of the other species formerly taken also occurred. Several new species were also added to the fauna; among these are two fine species allied to *Munida*.

Of Cephalopods,† besides the usual forms, we took one new species,‡ belonging to the genus *Abralia* of Gray, a genus not known from the American coast before. A *living* specimen of the *Argonauta argo* was caught in a dip-net while swimming at the surface, by Dr. Kite. This was taken about 100 miles south of the eastern end of Long Island. We took a fine large specimen of *Eledone verrucosa* V., in about 700 fathoms (station 1123); and the second known example of the large *Rossia megaptera* V., in 640 fathoms (station 1124), the first one having been taken from a halibut's stomach at the Grand Banks.

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* The Crustacea of 1880 were enumerated and described by Prof. S. I. Smith, in Proc. Nat. Mus., iii, pp. 413–452, 1880. Some of those of 1881 are included by him in his report on the "Blake Crustacea," Bulletin Mus. Comp. Zool., pp. 1–108 (16 plates), June, 1882. The more difficult species here enumerated were identified by Professor Smith.

† The Cephalopods of this region have mostly been described and figured by the author in Vol. VII of these reports, 1882, and Trans. Conn. Acad., Vol. V.

‡ *Abralia megalops*, Verrill.—Small, eyes large; caudal fin, about two-thirds as long as the mantle, and much broader than long, transversely elliptical; 2d and 3d pairs of arms equal; dorsal a littler shorter; ventrals shortest. Sessile arms with two rows of hooks, which are replaced by small suckers on the distal third; tentacular clubs with two alternating rows of hooks, and with marginal suckers distally, on each side, alternating with the median hooks, and with proximal and terminal groups of smaller suckers. Color pale, with numerous small dark brown chromatophores above, larger and more crowded on the head and bases of arms; lower side with several larger, round, symmetrically placed, purplish-brown spots and with minute ones between them. Length of mantle, 15^{mm}; diameter of body, 7^{mm}; length of fin, 11^{mm}; breadth across fins, 18^{mm}; breadth of head, 7^{mm}; diameter of eye, 4.5^{mm}; length of dorsal arms, 13^{mm}; length of second pair, 14^{mm}; of third pair, 14^{mm}; of tentacular arms, 25^{mm}; of ventral arms, 0^{mm}. Probably this specimen is young. Described from alcohol.

List of off-shore stations occupied by the Fish Hawk in 1882, to September 8.

Station.	Locality.	Fathoms.	Bottom.	Date.	Temp. F. Bottom.	Temp. F. Surface.	Hour.
	OFF CAPE COD.						
	Nauset Beacon:						
1078	NW. ¼ N. 10 miles	55	Fine sandy mud	Aug. 2	37°	63°	7.30 a.m.
1079	NW. by W. ½ W. 8¼ miles	61½	Fine sand	Aug. 2	37	63.5	8.40 a.m.
1080	NW. by W. ½ W. 6½ miles	55	....do	Aug. 2	37	61.5	9.40 a.m.
1081	W. by S. 5½ miles	33½	Gravel and pebbles	Aug. 2	39	59	10.50 a.m.
	Cape Cod Lt.:						
1082	NW. ¾ N. 11½ miles	28	Coarse gravel	Aug. 2	40	59	11.45 a.m.
1083	W. by N. 15 miles	83½	....	Aug. 2	38	64	12.45 p.m.
1084	W. NW. ⅜ W. 8 miles	37½	Coarse sand	Aug. 2	38	62.5	2.30 p.m.
	Race Point:						
1085	S. 33° E. 2 miles	34½	Fine sandy mud	Aug. 3	39	64	6.15 a.m.
1086	S. 20° W. 2¾ miles	34	Fine sand	Aug. 3	39.5	64	7.00 a.m.
	Cape Cod Lt.:						
1087	S. SW. 7 miles	44	Gray sand	Aug. 3	39	62.5	8.30 a.m.
1088	SW. ¾ W. 9½ miles	90	Coarse sand	Aug. 3	38	62	9.50 a.m.
1089	SW. ¾ W. 14 miles	110	Gray mud	Aug. 3	38.5	63	10.10 a.m.
1090	SW. ¾ W. 13¾ miles	110	....do	Aug. 3	38.5	62	11.50 a.m.
	OFF MARTHA'S VINEYARD.						
	N. Lat. W. Long.						
1091	40°03′00″ 69°44′00″	65	Gray sand, shells	Aug. 11	46	75	5.30 a.m.
1092	39 58 00 69 42 00	202	Gray sand	Aug. 11	41	75	6.54 a.m.
1093	39 56 00 69 45 00	349	Sandy blue mud	Aug. 11	40	75	8.35 a.m.
1094	39 57 00 69 47 00	301	Blue mud	Aug. 11	40	76	10.10 a.m.
1095	39 55 28 69 47 00	321	Soft green mud	Aug. 11	40	76	11.55 a.m.
1096	39 53 00 69 47 00	317	Green mud	Aug. 11	40	75.5	1.39 p.m.
1097	39 54 00 69 44 00	158	Fine sand	Aug. 11	45	75.5	3.10 p.m.
1098	39 53 00 69 43 00	156	....do	Aug. 11	43.5	75	4.35 p.m.
1107	40 02 00 70 35 00	116	Gray mud	Aug. 22	48	71	6.00 a.m.
1108	40 02 00 70 37 30	101	Fine sandy gray mud	Aug. 22	48	71	6.55 a.m.
1109	40 03 00 70 38 00	89	Gray mud	Aug. 22	49	71	7.55 a.m.
1110	40 02 00 70 35 00	100	Fine sandy gray mud	Aug. 22	47	72	9.10 a.m.
1111	40 01 33 70 35 00	124	Fine sand	Aug. 22	47	72	10.45 a.m.
1112	39 56 00 70 35 00	245	Green sandy mud	Aug. 22	43	72	12.43 p.m.
1113	39 57 00 70 37 00	192	Green mud	Aug. 22	43	72	1.45 p.m.
1114	39 58 00 70 38 00	171	....do	Aug. 22	43	72	2.40 p.m.
1115	39 59 00 70 41 00	146	Green sandy mud	Aug. 22	45	72.5	3.28 p.m.
1116	39 59 00 70 44 00	144	Hard sandy mud	Aug. 22	46	72	4.20 p.m.
1117	40 02 00 70 45 00	89	Fine sand	Aug. 22	48	72	5.30 p.m.
1118	40 03 00 70 45 00	70	....do	Aug. 22	49	72	6.20 p.m.
	OFF NANTUCKET, S. SE.						
1119	40 08 00 68 45 00	97	Sand, shells	Aug. 26	48	65	6.32 a.m.
1120	40 05 00 68 48 00	194	Fine sand, stones	Aug. 26	43.5	65	7.41 a.m.
1121	40 04 00 68 49 00	234	Fine sand, foss. stones	Aug. 26	41.5	65	9.05 a.m.
1122	40 02 00 68 50 00	351	Sand and stones	Aug. 26	40.5	67	10.28 a.m.
1123	39 59 45 68 54 00	787	Green sandy mud	Aug. 26	39	69	12.00 m.
1124	40 01 00 68 54 00	640	Fine sand, foss. stones.	Aug. 26	39	65	4.01 p.m.
1125	40 03 00 68 56 00	291	Sandy mud	Aug. 26	40	64	5.45 p.m.
	OFF BLOCK ISLAND, S.						
1137	39 40 00 71 52 00	173	Fine sand	Sept. 8	46	70	6.00 a.m.
1138	39 39 00 71 54 00	168	Fine soft sand	Sept. 8	46	71	7.24 a.m.
1139	39 37 00 71 55 00	291	Sandy mud	Sept. 8	44	72	8.48 a.m.
1140	39 34 00 71 56 00	374	Sandy mud, gravel, peb.	Sept. 8	40	73	10.35 a.m.
1141	39 32 00 71 57 00	389	Sandy mud	Sept. 8	40	74	12.27 p.m.
1142	39 32 00 72 00 00	322	Fine sandy mud, peb	Sept. 8	41	74	1.52 p.m.
1143	39 29 00 72 01 00	452	Sandy mud	Sept. 8	40	74	3.36 p.m.
1144	39 31 00 72 06 00	386	Soft sandy mud	Sept. 8	41	74	6.00 p.m.
	OFF MARTHA'S VINEYARD. SCHOONER JOSIE REEVES.						
1145	40 03 00 70 28 00	135	Fine sand	Sept. 20	......	......	......
1146	40 02 00 70 41 00	140	......do	Sept. 21	......	......	......
1147	40 01 00 71 02 00	125	....	Sept. 22	......	......	......
1148	39 54 00 71 22 00	110	Hard sand, sponges	Sept. 23	......	......	......
1149	....	......	......do	....	......	......	......
	OFF MARTHA'S VINEYARD. FISH HAWK.						
1150	39 58 00 70 37 00	140	Sand	Oct. 4	47°	62°	6.35 a.m.
1151	39 58 30 70 37 00	125	......do	Oct. 4	48	62	7.45 a.m.
1152	39 58 00 70 35 00	115	......do	Oct. 4	48	62	8.42 a.m.
1153	39 54 00 70 37 00	225	Sand, mud	Oct. 4	44	62.5	10.45 a.m.
1154	39 55 31 70 39 00	193	......do	Oct. 4	......	62.5	12.10 p.m.
1155	39 52 00 70 30 00	554	Very fine sand, soft mud.	Oct. 4	40	63	4.06 p.m.

Several shells were added to our lists, some of them of special interest. Among these is a fine new species of *Trophon*,* from 70 fathoms, and four species of Chitonidæ, of which one from 640 fathoms represents an Australian genus, *Placophora*,† not before known in the Atlantic. The other three are *Hanleyia mendicaria*, 317 fathoms; *Leptochiton alveolus*, in 291 and 640 fathoms; and what appears to be the true *Trachydermon exaratus* (G. O. Sars), in 194 fathoms. *Choristes elegans* was again found in old skates' eggs, in 640 fathoms, and in the same situation we found *Cocculina Beanii* and *Addisonia paradoxa* Dall. The latter was taken several times in 89 to 640 fathoms. A fine living specimen of *Dolium Bairdii* was taken in 192 fathoms. Two living specimens of *Mytilimeria flexuosa* ‡ occurred in 349 fathoms, associated with *Pecchiolia gemma* V., also living; a fresh valve of *Pholadomya arata*, in 108 fathoms; *Axinopsis orbiculata* G. O. Sars, in 202 fathoms; *Modiolaria polita* V. & S., in 321 fathoms. In trawl-wings, station 1141, 389 fathoms, we took four examples of *Clione papilionacea* Pallas, associated with a living specimen of *Cavolina longirostris*.

The southern species of Pteropods were comparatively scarce this

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* *Trophon Lintoni* Verrill & Smith.—Shell stout, rough, with six very convex, somewhat shouldered whorls, crossed by about nine very prominent, thick, obtuse ribs; whole surface covered with strong, elevated, obtuse, scaly, revolving cinguli, usually alternately larger and smaller, separated by narrow, deep grooves; they are crossed by arched scales or lines of growth. Aperture broad; canal short, narrow, a little curved; umbilical pit distinct, but small. Length, 28^{mm}; breadth, 17^{mm}; length of canal and body-whorl, 19^{mm}; length of aperture, 15.5^{mm}; its breadth, 7.5^{mm}. Station 1118. Named in honor of Prof. E. Linton, of our party.

† *Placophora* (*Euplacophora*) *Atlantica* V. & Smith.—Broad ovate, with the marginal membrane very broadly expanded in front, and covered with fine spinules above and below, distinctly radially grooved beneath, and with intermediate rows of small verrucæ. Edge of mantle, in front of head, digitately divided into about seven lobes, the anterior ones slender, acute. Gills about 16 on each side, occupying more than two-thirds the length of the foot. Shell, broad-ovate, with short, broad anterior valves, the posterior one very small, lunate, and a little emarginate at the posterior edge; anterior one very broadly rounded, short hind edge with a slight rounded median notch, surface uniformly granulous and faintly radially grooved; inserted edge narrow, with about 30 irregular denticles; middle valves have a slight median beak at the hind edge, their lateral areas are strongly marked, crossed with diagonal rows of low rounded granules, separated by narrow radial grooves; central areas with smaller and less distinct granules, and transverse lines of growth. Color, rusty brown. The largest example is, in alcohol, 32^{mm} long; breadth, 26^{mm}; length of shell, 21^{mm}; breadth of shell, 18^{mm}; length of anterior valve, 4^{mm}; breadth, 15.5^{mm}.

I am indebted to Mr. W. H. Dall for the generic determination of this species.

‡ The animal of this shell, in alcohol, has a small and short anal tube, surrounded by small papillæ, and a very much larger incurrent orifice, occupying a ventral position, and surrounded by numerous long and large tentacle-like papillæ; the orifice for the foot is small; the edge of the mantle is bordered by very small papillæ. There is a slender translucent byssus. The hinge ligament is strengthened by a distinct ossicle, placed lengthwise, more or less ovate in form, with the smaller end next the hinge-teeth, and somewhat truncated.

Pecchiolia gemma also has an ossicle, similarly placed, with the posterior end broader and notched in the middle, the narrower end truncated.

season, and the very large species of *Salpa*, so abundant hitherto, was only once met with this year, but the small species (*S. Caboti*) occurred in large numbers, and with it several very brilliant species of *Saphirina* were taken.

EVIDENCE OF GREAT DESTRUCTION OF LIFE LAST WINTER.

One of the most peculiar facts connected with our dredging this season (1882) was the scarcity or absence of many of the species, especially of Crustacea, that were taken in the two previous years, in essentially the same localities and depths in vast numbers—several thousands at a time. Among such species were *Euprognatha rastellifera*, *Catapagurus socialis*, *Pontophilus brevirostris*, and a species of *Munida*. The latter, which was one of the most abundant of all the Crustacea last year, was not seen at all this season. An attempt to catch the "Tile-fish" (*Lopholatilus*) by means of a long trawl-line, on essentially the same ground where eighty were caught on one occasion last year, resulted in a total failure this year. It is probable, therefore, that the finding of vast numbers of dead tile-fishes floating at the surface in this region last winter, as was reported by many vessels, was connected with a wholesale destruction of the life at the bottom, along the shallower part of this belt (in 70 to 150 fathoms), where the southern forms of life and higher temperatures (48° to 52°) are found. This great destruction of life was probably caused by a very severe storm that occurred in this region at that time, which, by agitating the bottom-water, forced outward the very cold water that, even in summer, occupies the great area of shallower sea, in less than 60 fathoms, along the coast, and thus caused a sudden lowering of the temperature along this narrow, comparatively *warm zone*, where the tile-fish and the crustacea referred to were formerly found.

As the warm belt is here narrow, even in summer, and is not only bordered on its inner edge, but is also underlaid by much colder water, it is evident that even a moderate agitation and mixing up of the warm and cold water might, in winter, reduce the temperature so much as to practically obliterate the warm belt at the bottom. But a severe storm, such as the one referred to, might even cause such a variation in the position and flow of the tidal and other currents as to cause a direct flow of the cold inshore waters to temporarily occupy this area, pushing outward the Gulf Stream water. The result would be the same in either case, and could not fail to be destructive to such species as find here nearly their extreme northern limits.

In order to test this question more fully, Professor Baird also employed a fishing vessel, the Josie Reeves, to go to the grounds and fish systematically and extensively for the tile-fish. On her first trip, ending September 25, she did not find any Tile-fish, but took another food fish (*Scorpæna dactyloptera*), known on the European coast, and first taken by us in 1880.

ABUNDANCE OF LIFE.

A large number of species belonging to various zoological groups, are found in this region living gregariously, in vast numbers, at particular spots, while they may not occur at all, or only sparingly, at other stations similar in depth, temperature, and character of the bottom. Thus, among echinoderms, the large ophiuran, *Ophioglypha Sarsii*, occurred at stations 918 and 1026, in 45 and 182 fathoms, in vast quantities; at 1026, between two and three barrels (probably over 10,000 specimens) came up in a single haul; the elegant star-fish, *Archaster Agassizii* V., occurred in great numbers at station 997, in 335 fathoms; the more common *A. Americanus* V. has often occurred in very great profusion, many thousands being taken at a haul, at several stations. A slender-armed *Amphiura* occurred in very great numbers at station 920, in 68 fathoms, but was seldom met with elsewhere. The *Astrochele Lymani* V. occurred at 939, 1028, 1029, and other stations in abundance, twining its arms closely around the branches of the coral, *Acanella Normani* V. A small crinoid (*Antedon dentata* Say) occurred at station 1038, in 146 fathoms, in the greatest profusion, over 10,000 specimens coming up at a single haul. As usual, nearly all the specimens had dismembered themselves before reaching the surface. The great abundance of this and other recent crinoids, at certain localities, is parallel with the abundance of many ancient fossil crinoids, in particular regions. Many other echinoderms might also be cited, though affording less conspicuous examples.

Several very large actinians, among them *Bolocera Tuediæ*, *Actinauge nodosa*, and other related species, occurred in great quantities at many stations (924, 937, 938, 998), more than a barrel of them frequently coming up in the trawl. The pretty bush-like gorgonian coral, *Acanella Normani* V., was very abundant at stations 938, 947, 1029. Of the spiny sea-feather, *Pennatula aculeata*, we took over 500 specimens, at station 1025, and nearly a hundred of *Anthomastus grandiflorus* V., at station 1029; both these forms are usually scarce. The coral, *Flabellum Goodei* V., was abundant at 894, 895, 925, 952. The large and curious annelid, *Hyalinœcia artifex* V.,* remarkable for the very large, quill-like, free tube that it constructs, must be excessively abundant in many places, as at 869, 892, 938, 998, 1025, 1026; for several thousands are frequently taken at a single haul, and sometimes even four or five bushels, as at station 1032.

Among Crustacea, such cases are also very common. A species of *Munida* (*M. Carabœa* Smith) was very abundant at some stations (871, 922, 941), so that 2,000 or more sometimes came up in one haul, and the same is true of several species of shrimp (*Pontophilus brevirostris* Smith, at 865, 871, 878, 941; *Pandalus leptocerus* S., at 870, 878, etc.); certain hermit crabs, as *Hemipagurus socialis* S., at 871, 874, 877, 878, 940, 941, 944; the maioid crab, *Euprognatha rastellifera* Stimp., at 871–4, 878, 921, 941, etc.

* Figured in Bulletin Mus. Comp. Zool., vol. xi, pl. 6, fig. 1. 1883.

One of the most striking instances was the occurrence of a very remarkable and hitherto rare hermit crab (*Parapagurus pilosimanus* Smith), with its associated, investing polyp (*Epizoanthus paguriphilus* V.), which is a true commensal, forming, out of its own tissues, the habitation of the crab; and hitherto it has not been found elsewhere than upon the back of this particular species of crab, which, likewise, has rarely been found without its polyp. Of these associated creatures we took about 400 couples, at station 947, in 312 fathoms, at one haul. It had previously only been known by a few specimens taken by the Gloucester halibut fishermen, in deep water, off Nova Scotia, and by ourselves, in 1880.

*LIST OF DEEP-WATER ECHINODERMATA TAKEN BY THE FISH HAWK, 1880–1882.**

HOLOTHURIOIDEA.

LOPHOTHURIA FABRICII Verrill. 234 fathoms.
Station 1121, 1 young. Northern, in shallow water.

THYONE SCABRA Verrill. 51–640 fathoms.
S. 870, 871, 876, 877, 894, 898: 919, 939, 943, 949, 1038, 1040, 1049: 1092, 1124, 1142.

TOXODORA FERRUGINEA Verrill. 100–155 fathoms.
S. 870, 871, 873, 876, 877: 943, 949.

MOLPADIA TURGIDA Verrill. 120–787 fathoms.
S. 876 (1): 1026 (2): 1123.

ECHINOIDEA.

SCHIZASTER FRAGILIS (Duben & Koren) L. Agassiz. 56–321 fathoms.
S. 865, 869, 870, 871, 873, 874, 876, ab., 877, ab., 896: 939–941, 943, 945, 950, 1025, ab., 1026, 1032, ab., 1035, 1036, 1038, ab., 1043, 1045, 1047: 1080, 1091, 1092, 1094–1098, 1110, 1113, 1114, 1119, 1121, 1125, 1138, 1145, 1153, 1154.

SCHIZASTER CANALIFERUS L. Agassiz (variety?). 65–134 fathoms.
S. 871, 873, 874, 876, 877: 921–922 (9), 940, 941, 949: 1108, 1110, 1151, 1152.

BRISSOPSIS LYRIFERA (Forbes) L. Agassiz. 65–194 fathoms.
S. 870: 921, 1038: 1097, 1120. Europe and W. Indies.

SPATANGUS PURPUREUS Leske. 89–158 fathoms.
S. 940 (1 large, living): 1097, 1098, 1109, 1119. Europe and W. Indies.

ECHINOCYAMUS PUSILLUS (Müller) Gray. 146 fathoms.
S. 1038 (1). Europe and W. Indies.

ECHINARACHNIUS PARMA Gray. 10–219 fathoms.
S. 951, 985–989, very ab., 1038, many: 1097, 1109, 1117, 1119, 1120.

PHORMOSOMA SIGSBEI A. Agassiz. 458–787 fathoms.
S. 1029 (1 living): 1123. W. Indies (A. Ag.).

ECHINUS GRACILIS A. Agassiz. 86–202 fathoms.
S. 872 (2): 940 (7), 1038, 1039, 1046 off Delaware Bay, 3 large: 1092, 1097, 1098, ab., 1109, 1119.

* The colons in this list separate the numbers of stations belonging to different years.

ECHINUS WALLISI A. Agassiz. (=*E. Norvegicus* in list of 1880.) 156–640 fathoms.

S. 893, 894: 939, 1028, 1029: 1097, 1098, 1124.

TEMNECHINUS MACULATUS A. Agassiz. 115 fathoms.

S. 871. Gulf of Mexico (A. Ag.).

DOROCIDARIS PAPILLATA A. Agassiz (variety). 104–158 fathoms.

S. 1038 (1), 1046 off Delaware Bay (5): 1097, 1098.

HEMIPEDINA CUBENSIS A. Agassiz. 194 fathoms.

S. 1120. Gulf of Mexico.

ASTERIOIDEA.

ASTERIAS VULGARIS (Stimpson) Verrill. Shore to 208 fathoms.

S. 869: 917–920, 994 (3), 1032 (1), 1035 (12), 1037 (12), 1046 (1), 1047: 1092, abundant in shallower water.

ASTERIAS TANNERI Verrill. 56–194 fathoms.

S. 869–872, 896: 922, ab., 923, ab., 940, 941, ab., 949, 950, 1035, 1047, ab.: 1097, 1098, 1119, 1120.

ASTERIAS BRIAREUS Verrill. 31–57 fathoms.

S. 899, 900.

STEPHANASTERIAS ALBULA (Stimpson) Verrill. 64–130 fathoms.

S. 865–867, ab., 870–872: 921–923, 940, 949–950, ab., 1035, ab., 1036, very ab., 1043, ab., 1046, 1047: 1110, 1114, 1148.

CRIBRELLA SANGUINOLENTA (Müller) Lütken. Shore to 194 fathoms.

S. 865–867, 871, 872, 900: S. 928, 933, 934, 949, 956, 957, 985–987, 1009, 1036: 1108, 1114, 1115, 1117, 1120. Commoner and larger, in shallower water, nearer the coast.

SOLASTER EARLII Verrill. 234 fathoms.

S. 1121. Northern.

LOPHASTER FURCIFER Verrill. 234–640 fathoms.

S. 1121, 1124. Northern and European.

DIPLOPTERASTER MULTIPES (Sars) Verrill. 124–640 fathoms.

S. 869, 878, 895: 924, 925, 938, 939 (13), 940 (10), 945 (11), 947, 951, very large, 1025, 1026, 1032 (22), 1033, 1038, 1047: 1096–1098, 1111–1114, 1116, 1120, 1121, 1124, 1125, 1137, 1138, 1153, 1154.

PORANIA GRANDIS Verrill. 65–234 fathoms.

S. 865, 869, 872: 923, 940, sev., 949, 950, sev., 1039, 1046 (9 j.): 1092, 1097, ab., 1098, ab., 1108–1110, 1117, 1121.

PORANIA SPINULOSA Verrill. 86–640 fathoms.

S. 869, 872, 879, 894, 895: 925, 938, 939, 945, 946 (10), 951, 998, 994, 1025, 1032: 1096, 1112, 1113, 1120, 1121, 1124, 1142, 1153, 1154.

PORANIA BOREALIS Verrill. (=ASTERINA BOREALIS V.) 192–225 fathoms.

S. 869, 879.

ASTROGONIUM GRANULARE M. and Tr. 156–640 fathoms.

S. 1098, 1124. Northern and European.

ODONTASTER HISPIDUS Verrill. 57–487 fathoms.

S. 865, 868, 869, ab., 871–873, 878, 879, 892, 894, 895, 899: 921, 922,

940, ab., 946, 947, 949, 950, ab., 994, 1043, ? 1049 (1 j.): 1091, 1092, 1095, 1097, 1098, 1109, 1110, 1114, 1115, 1117, 1120, 1152.

ARCHASTER FLORÆ Verrill. 100–410 fathoms.

S. 869, 873, 879, 881, 895: 924, 925, 938–940, 943, 945, 946, 951, 997, ab., 1025, ab., 1026, 1028, 1032, 1033, 1038: 1093–1096, 1111–1113, 1116, 1121, 1125, 1146, 1153, 1154.

ARCHASTER AMERICANUS Verrill. 56–225 fathoms; ab. in 64–150.

S. 865–868, very ab., 871, ab., 873–876, very ab., 877, 879, 896, 899: 918, ab., 920–921, very ab., 940–941, very ab., 945, 949, 950, very ab., 1025, 1035–1037, very ab., 1038, 1040, 1043, 1046: 1091, 1092, 1097, 1108–1110, 1115, 1117, 1120, 1148.

ARCHASTER AGASSIZII Verrill. 182–787 fathoms.

S. 879, 880, 881, 891–894, 895, 898: 938, 939, 946, 947, ab., 952, 994, ab., 997, very ab., 998, 1025–1026, ab., 1028, 1029, 1049: 1093, 1122, 1124, 1140, 1142, 1143, 1153.

ARCHASTER PARELII Düben & Koren. 225–487 fathoms; scarce.

S. 879, 892–894: 938, 939, 947, 952, 1028, (1 j.), 1029, 1049 (6): 1140, 1143.

ARCHASTER TENUISPINUS Düben & Koren. 368 fathoms. S. 994 (1).

ARCHASTER MIRABILIS (?) Perrier. 317 fathoms.

S. 938 (1). Gulf of Mexico (A. Ag.).

ARCHASTER ARCTICUS M. Sars. 183–410 fathoms.

S. 925, 938, 939, 946 (2), 951 (3), 1028, 1032, sev., 1033: 1095, 1096, 1120, 1121, 1125, 1154.

ARCHASTER BAIRDII Verrill. 351–396 fathoms. S. 952 (6): 1122.

LUIDIA ELEGANS Perrier. 53–192 fathoms.

S. 865–872, many large, 871 (17), 873, 876, 877: 919, 921–923, ab., 940–941, ab., 949, 950, 1035, 1036, 1038, 1047.

CTENODISCUS CRISPATUS Düben & Koren. 182–321 fathoms.

S. 879: 938, 939 (5), 1025, sev., 1026, 1032: 1095, 1096.

OPHIUROIDEA.

OPHIOGLYPHA SARSII Lyman. 30–368 fathoms.

S. 865–871, ab., 873, ab., 877, ab., 879, 895: 917, 918, very ab., 919, 924, ab. l., 925, 940, 943, 989–994, 991, ab., 1025, ab., 1026, very ab., l., 1032, 1033, ab. l., 1035, 1038, 1047: 1092, 1093, 1096, 1111, 1114, 1115, 1121, 1150–1154.

OPHIOGLYPHA SIGNATA Verrill. 100–264 fathoms.

S. 869, 870 (10), 873 (24), 875, 877, 878: 939, 1038, 1039: 1150, 1151, 1152, 1154.

OPHIOGLYPHA (OPHIOPLEURA) AURANTIACA Verrill. 82–317 fathoms.

S. 869 (2), 872, 880 (2), 895 (4): 938, 939, 946 (6), 951: 1092, 1121, 1124, 1152.

OPHIOGLYPHA CONFRAGOSA Lyman. 238–616 fathoms.

S. 895 (1): 937 (1), 938 (2, large), 1028 (13), 1029.

OPHIOMUSIUM LYMANI W. Thomson, 238–787 fathoms.

S. 891 (11 j.), 892 (5), 895 (1): 994 (2), 1029: 1122, 1123.

OPHIACANTHA BIDENTATA Lyman=O. SPINULOSA M. & Tr. 192–640 fathoms.

S. 869: 945, 1029: 1122, 1124.

OPHIACANTHA MILLESPINA Verrill. 100–640 fathoms.

S. 869, ab., 870, 871, 873, 895: 924, 925, ab., 938, 939–940, ab., 945, 951, 1026, 1032–1033, ab., 1034, 1035, 1038, ab., 1039: 1092, 1093, 1096, 1098, 1121, 1122, 1124, 1139, 1150.

OPHIOPHOLIS ACULEATA Gray. Shore to 640 fathoms.

S. 865, 869, 871, 872, 879, 895, 899, 900: 920, 922, 924, 925, 939, 940, 943, 945–947, 949, 951, 986, 989, 1025, 1032, ab., 1033, 1035, 1036, 1038, very ab., 1039, ab., 1043: and many stations in 1882.

AMPHIURA OTTERI (?) Ljungmann. 192–480 fathoms.

S. 869, 880, 891, 895, 898: 997, 998, 999, 1026, 1028: 1093.

AMPHIURA ELEGANS Norman, var. TENUISPINA Ljung. 120–487 fathoms.

S. 869, 871, 876, 892, 894, 895: 1038: 1093, 1140.

AMPHIURA MACILENTA Verrill (?=*A. abdita* young). 53–115 fathoms.

S. 865, 871: 919, 920, very ab., 921, 941.

OPHIOCNIDA OLIVACEA Lyman. 64–192 fathoms.

S. 865, 869, 871, ab., 872, 873–877, ab., 878: 921, 940, 941, 949, ab., 1040, ab.

OPHIOSCOLEX QUADRISPINUS Verrill,* sp. nov. 234 fathoms.

S. 1121, two examples.

OPHIOSCOLEX GLACIALIS Müller & Troschel. 115–321 fathoms.

S. 869, ab., 870, 871, 879, 895: 924, 925, 939, 940, 945, ab., 946, 951, 1025, ab., 1026, 1032, 1033: 1092, 1094, 1095, 1096, 1113, 1121, 1138, 1139, 1145, 1153, 1154.

ASTROCHELE LYMANI Verrill. 264–640 fathoms.

S. 938, 939, 1028, ab., 1029, ab., 1122, 1124, 1125, 1139.

ASTROPHYTON LAMARCKII M. & Tr. 194 fathoms.

S. 1120, abundant. Northern.

ASTRONYX LOVENI M. & Tr. 787 fathoms.

S. 1123. Northern.

CRINOIDEA.

ANTEDON DENTATA (Say) V.=ANTEDON SARSII (D. & K.). 85–640 fathoms.

S. 868–871, 873–876, 878–880, 895, 897: 925, 939, ab., 940, 943–946, 949, 1025–1027, 1032, 1033, ab., 1035, 1038, very ab., 1043, 1047, 1048: 1092, ab., 1095, 1096, 1098, 1111, 1112, 1116, 1121, 1124, 1137, 1138, ab., 1139, 1145, 1146, 1150, ab., 1151, 1152.

RHIZOCRINUS LOFOTENSIS Sars. 640 fathoms.

S. 1124. European and West Indian.

* This is a large species, with four arm-spines; a slender, acute tentacle-scale; and narrow, oblong, ventral arm-plates.

ADDITIONS TO THE FAUNA OF VINEYARD SOUND—SURFACE DREDGINGS.

During the intervals between the Gulf Stream trips, shore collecting and a large amount of surface dredging, both by day and night, were done in the vicinity of Wood's Holl, by means of the two steam launches belonging to the Fish Commission. In the surface dredging Mr. Emerton took the most active part. The surface work was very productive this season, not only affording a vast number of larval forms of Crustacea, Echinodermata, Annelida, Mollusca, etc., but also a large number of adult Annelida, belonging to the Syllidæ and various other families, including a number of very interesting new species. Certain species of *Autolytus* were unusually abundant. Many thousands of specimens of *A. varians* V. (formerly *A. ornatus* V.) were often taken in a single evening, the males of both the red and green varieties being far more numerous than the females, which were always bright red when containing eggs. The males of a much larger species, the *A. ornatus* (*Procerœa ornata* V., 1873, stem-form), were also abundant; the much larger females, which are transversely banded with red, were taken in smaller numbers. A small but very remarkable new species (*A. mirabilis*),* first discovered by us in 1881, was not uncommon, but only the females were taken at the surface. The stem-form occurred among hydroids and ascidians at moderate depths. This species is remarkable for the large number of sexual individuals that may be developing, simultaneously, from the stem-form. It is not uncommon to find it carrying five or six sexual individuals, in various stages, one behind another.

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* *Autolytus mirabilis* V., Trans. Conn. Acad., iv, pl. 13, figs. 8–10.—Stem-form long and slender. Antennæ, tentacular cirri, first pair dorsal cirri, and caudal cirri very long and slender, 4–6 times the breadth of the body; median antenna and first dorsal cirrus longest; second dorsal cirri twice the breadth of body; others varying in length, but mostly longer than breadth of body; two long, narrow epaulets, extending from the head back to third body-segment. Stomach large, oblong; pharynx slender, with one flexure, denticulate at the end. The most anterior formation of the sexual young takes place behind the fiftieth segment; in one individual (see Fig. 8, loc. cit.) six female individuals follow one another, the largest one being nearly ready to separate, and having 22 segments, with a well developed head, four eyes, and long antennæ. Some detached females, bearing eggs, have, however, no more than 16 to 20 segments.

Vineyard Sound and off Gay Head, 4 to 8 fathoms, among hydroids, 1881 and 1882.

Female: Small, with only one pair of slender cirri, longer than breadth of head, on the buccal segment; two anterior body-segments with only short setæ; capillary setæ begin on the third segment; two pairs of eyes close together, the anterior larger; three antennæ nearly equal, long and slender, three or four times the breadth of the head; caudal cirri, when fully developed, about as long as the antennæ; dorsal cirri slender, longer than breadth of body. Length 3^{mm} to 3.5^{mm}. Color, when containing eggs, dark olive-brown; after eggs are laid, pale greenish; eyes dark brown. Wood's Holl, surface, evening, August 2 to September 18, 1882; off Gay Head, with the stem-form, 1881. Description from life.

A very singular Syllidian,* of which only the sexual forms are known, was taken several times at the surface, in the evening. We also took these in 1880 and 1881. They have probably been detached from a very different stem-form. The genus is allied to *Chætosyllis* Mgn., but the head is entirely destitute of antennæ. It has four large eyes and swims very actively.

Odontosyllis lucifera V., of both sexes, was very common in the surface nets all through August and to September 15, but mainly in the evening. With the latter a smaller and more delicate species usually occurred, but in less abundance. This belongs to the genus *Eusyllis*† and has been known to me for a number of years.

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* *Tetraglene* Grube, 1863.—Sexual forms: Head distinct, with four large eyes, but with no other appendages. Segments behind the head similar, all bearing large parapodia, with long setæ, a long dorsal cirrus, and a smaller slender ventral cirrus. Caudal cirri two, long, submoniliform.

Tetraglene agilis Verrill.—Trans. Conn. Acad., iv, pl. 25, Fig. 10.—Rather large and stout, head broader than long, subtruncate, or even emarginate in front, constricted abruptly behind; eyes large with front lens round, the two pairs near together, the anterior a little larger and wider apart. Body-segments separated by deep constrictions; parapodia with large setigerous lobe, as long as the breadth of the segments; setæ numerous, longer than the parapodia, the shorter ones with a long, slender article; capillary setæ begin on the third segment; cirri more or less moniliform, slender, tapered, about four times as long as the breadth of the head; caudal cirri similar to dorsal; ventral cirri slender, smooth. Color of males, yellowish white; of females, pale orange yellow or salmon; eyes brown; eggs reddish, laid August 5, 1882. Length of largest (♀) about 25^{mm}; males about 20^{mm}. Taken in the evening, at the surface, near Nomansland, September, 1880; Wood's Holl, August 4, 1881, and from August 5 to September 12, 1882. Description from life.

† *Eusyllis tenera* Verrill, Trans. Conn. Acad., iv, pl. 13, Fig. 12, pl. 14, Figs. 4, *a. b.*—Slender, 5^{mm} to 7^{mm} long, with very long, slender antennæ and cirri, which are often curled in spirals, and irregularly transversely constricted, smoothish in full extension. Pharynx short, straight, with a large, sharp median tooth at the extreme anterior end; the edge of the tube is divided into numerous (about 30) small, sharp denticles, becoming obsolete on the lower side; sheath of pharynx with a circle of larger, soft papillæ (about 13) in front of the tube. Stomach large, oblong; intestine with a pair of short, rounded, lateral pouches at the end of the stomach. The median antenna and upper tentacular cirri are 3 to 6 times as long as the breadth of the body; lateral antennæ and lower tentacular cirri shorter; the longest dorsal cirri are 5 to 6 times as long as breadth of body; shorter dorsal cirri alternate irregularly with the long ones. The palpi are very flexible and changeable in form, prominent, flattened, tapered or oblong, obtuse. Head rounded in front, widest in front of the middle, opposite the largest eyes. Eyes six; four larger ones nearly equal, the anterior a little larger and wider apart, near the sides of the head; the minute frontal eyes are near the inner bases of the antennæ. Setæ with an oblong, blade-shaped terminal article, obtuse and slightly bidentate at tip.

Sexual individuals have, also, fascicles of long capillary setæ, beginning on the fourteenth setigerous segment.

Color translucent bluish white, pinkish or purplish-brown anteriorly, and more or less purplish-brown or blue-gray on the sides of the body and more decidedly on the bases of the parapodia; cirri white; pharynx and stomach pale brown; intestine brown or olive-green, constricted between the segments; eggs showing through, purplish-brown; eyes dark red.

New Haven to Vineyard Sound; frequent at surface in evening, at Wood's Holl,

Another interesting new species, which was taken at the surface, both this year and last, appears to belong to the genus *Syllides.** Among the less common forms of Syllidæ were *Grubea Websteri* V.,† *Sphæro-*

from August 2 to September 15, 1881, 1882. Also dredged in Vineyard Sound in 8–12 fathoms, among bryozoa and *Amorœcium pellucidum.* Allied to *Syllis fragilis* Webs., which probably also belongs to *Eusyllis.* Described from life.

**Syllides setosa* Verrill, Trans. Conn. Acad., pl. 24, Figs. 11, 11c.—Body not very slender, with about 50 segments and large parapodia. Head changeable, usually short, obtusely rounded or subtruncate in front, rounded laterally, closely united to buccal segment. Palpi short, often not visible from above; below they appear as flat lobes. Eyes six; two median ones largest, close to sides of head; posterior ones a little smaller and nearer together, and close to the others; front ones very small, close to the outer bases of the palpi. The antennæ and four tentacular cirri are all similar in size, form, and color, but the odd antenna is a little the longest (about three times breadth of head), and the tentacular cirri are usually somewhat shorter than the lateral antennæ (or about twice the breadth of the head); all are contractile and somewhat changeable in form; usually they are distinctly clavate, with narrow bases and obtuse, swollen, transversely wrinkled tips. Anterior dorsal cirri long, slender, usually more or less clavate, with a distinct basal joint and numerous annulations, becoming more marked distally; they are as long as the antennæ, or longer, and about three times the breadth of the segments; they often increase in length on the first few segments, but are apt to vary irregularly; the longest are more than four times as long as the breadth of the segments. The ventral cirri are slender, tapered, with a distinct oblong terminal article; they arise far out on the parapodia and project beyond the setigerous lobe, but are not a third as long as the dorsals anteriorly; posteriorly they are relatively longer. The parapodia are very large in the middle region of the body, with a swollen base and long setigerous lobe. Caudal cirri three; lateral ones very long, transversely annulated, tapered, acute, often coiled spirally; median one small and slender. Setæ numerous, the compound ones with a long, narrow terminal blade, bidentate at the tip; simple long setæ begin singly on the eighth or ninth setigerous segment; fascicles of capillary setæ appear on the eighteenth, in our largest example. Pharynx very dark colored, large, short, stout, straight, surrounded with a broad sheath, apparently unarmed, but sometimes showing a pale, oblong spot, that might be taken for a feeble tooth, near the anterior end; its sheath has a circle of soft papillæ in front; stomach brown, large, oblong, usually slightly constricted near the front end, equal in length to about four segments (or to six in alcohol); intestine very large, with two rounded brown lobes close to the stomach. Color generally dull orange-yellow, or orange-brown, medially, due to the internal organs; the external parts are whitish; buccal segment brownish, intestine yellowish brown. Length of the largest specimen, in alcohol, 12^{mm}. Taken at the surface, evening, July 22, 29, and August 15, 1881; August 3 to September 12, 1882. Described from life. Another very much smaller form, with about 32 segments, perhaps distinct from the above, occurred. In this the antennæ and tentacular cirri are shorter, more decidedly clavate; palpi shorter, scarcely visible from above; setæ with a shorter and less slender article. The stomach and pharynx are dark brown. Bunches of capillary setæ begin on the tenth body-segment. Length about 3^{mm}.

†*Grubea Websteri* Verrill, Trans. Conn. Acad., iv, pl. 24, Figs. 6–8.—Small, slender, whitish, with about 33 segments. Three antennæ, both pairs of tentacular cirri, dorsal and caudal cirri all similar in shape, long-fusiform, thickest below the middle, tapering and acute, not differing much in size nor in length, but the first pair of dorsal cirri, and those following the eighth, are a little longer than the others or the antennæ; cirri longer than the breadth of the body opposite; ventral cirri small, slender. Head short, rounded in front and laterally; palpi large and prominent, tapered, united above nearly to the obtuse, rounded tips; eyes six; frontal ones minute,

syllis, sp., *Pædophylax longiceps* V., etc. The *Nereis megalops* V., both in the heteronereis-form (*Nectonereis*) and in the nereis-form (*N. alacris* V.), frequently occurred in our night excursions, and in September the young of the latter of all sizes, from those with only six or eight segments up to those that were 10^{mm} or more in length, occurred abundantly at the surface. These young are very active, translucent, and nearly white, with small, red specks over the surface. A very interesting new species, *Acrocirrus Leidyi* V.,* belonging to a genus hitherto not recorded from our coast, was taken at the surface several times this year, and also in 1881. *Podarke obscura* V. was often abundant at the surface, as well as in the soft mud, among eel-grass, in the harbor. Among other surface Annelida were *Cirrhinereis phosphorea* V. and *C. fragilis*, and a species of *Prionospio*, probably identical with *P. tenuis* (*Spiophanes tenuis* V., 1880). This was also taken from the harbor mud, in shallow water, last year. When perfect it has four pairs of gills, all fringed on one side (Tr. Conn. Acad., iv, pl. xix, Fig. 7). A singular larval form, probably belonging to this species, occurred once (September 9) at the surface.

Among the various larval forms of Annelids we were fortunate in obtaining a very large number of *Chætopterus pergamentaceus*, in various stages, from very young ones up to those having the adult characters distinctly developed. Of these Mr. Emerton made an excellent series of drawings. The adults of this interesting species were dug from the sand just below low-water mark, at Naushon I.,† by our party. The

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median largest and farthest apart, close to sides of head. Pharynx narrow, straight, a little swollen anteriorly, with a well-marked tooth close to the front edge; stomach oblong, occupying two or three segments, according to their extension; intestine with two rounded lobes, close behind stomach. Setæ with a rather long, flat, blade-like article, strongly fringed on the edge, with the tip distinctly bidentate, and not very slender; long, capillary, sexual setæ begin (when present) on the ninth setigerous segment, and continue on thirteen to seventeen. The eggs and young are carried on these same segments, usually four to each segment. Some examples (op. cit., pl. 25, Fig. 2) similar in other respects, have no sexual setæ and only two eggs to a segment. Three to eight hind segments are without sexual setæ and eggs. Length, 3^{mm} to 4^{mm}. Surface, Newport, R. I., 1880; Wood's Holl, Mass., July 28 to September 12, 1881, 1882. Described from life.

* *Acrocirrus Leidyi* Verrill, Trans. Conn. Acad., iv, pl. 19, Fig. 2.—Body slender, with distinct segments, covered with small papillæ. Head changeable, usually rounded, obtuse; eyes four, the front pair very minute; hind pair larger and wider apart; two large, long, usually clavate antennæ on front of head, near together. A pair of large, long, clavate cirri on first four segments, like the antennæ, but larger, the length three or four times the breadth of body. Ventral, compound setæ, with a very long, curved and hooked terminal article, begin singly on the second segment bearing cirri; long, slender, capillary dorsal cirri begin singly on the fourth segment, but form fascicles of six to nine farther back. Color dark olive-green to dark brown; cirri and antennæ paler green with yellow tips. Length, 10^{mm} to 15^{mm}; diameter of largest, about 1^{mm}. Wood's Holl, surface, evening, August 2 to September 9, 1881, and 1882. Described from life.

† This species was first discovered at this place in 1880 by Mr. Charles Webster and Mr. Vinal N. Edwards, from whom I received specimens at that time.

largest of these had U-shaped tubes, 28 to 31 inches in length and over an inch in diameter in the middle. In each tube there was usually a crab (*Pinnixa chætopterana* St.), associated with the worm. These tubes show, very beautifully, the way in which their size is continually increased by the occupant, which is incapable of emerging from it. The worm makes longer or shorter slits in the parchment-like tube, wherever it is to be enlarged (probably using for this purpose the sharp, stiff, lance-like setæ of the anterior segments), and after spreading the tube, from within, to the desired extent, it closes up the opening by means of a fusiform patch (like a "gore" or "gusset"), of the same material as the original tube, but differing slightly in color or luster, so that when the tube is cut open these neat patches show very distinctly on its inner surface.

From the sands of Naushon, at Hadley Harbor, our party also procured several living examples of an European shell, *Tellimya* (or *Montacuta*) *ferruginosa*, not before found on our coast. It was associated, at low-water mark, with living specimens of *M. bidentata* and another species of the family, Kelliadæ, *Corbula contracta*, etc. Drawings were made of the animals of all these by Mr. Emerton.

Of Gastropod veligers, about twenty species were taken in the surface nets. Some of these occurred in vast numbers, but I have not yet been able to identify more than half of the species. Among those recognized are *Anachis avara*, *Astyris lunata*, *Triforis nigrocincta*, etc. One of the largest and most interesting was that of a *Natica*. This had the velum divided into four long, narrow lobes, beautifully marked with brown at the tips. Many of these were kept till they lost the velum and developed the characteristic foot of *Natica*. The species is uncertain.

In a region that has been so thoroughly dredged in past years as Vineyard Sound, it was not to be expected that many new forms would be found, unless among the more minute species, or in those groups not hitherto studied on our coast. Yet one new Planarian,* of large size and with conspicuous colors, was taken, as well as various undescribed Rhabdocœla and Annelida.

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* *Stylochopsis zebra* V., sp. nov.—Body broad-eliptical, rather thick, or somewhat swollen. Tentacles small, near the front end, bearing several small ocelli; a cluster of small dorsal eyes in front of tentacles; minute, marginal ocelli, along the front edges. Color brown and pale yellow or whitish, in narrow, alternating, transverse stripes, which run directly across in the middle, but become more and more V-shaped as they approach each end. Length about 20^{mm}, breadth 12^{mm}. Great Harbor, shore; off Menemsha, 10 to 12 fathoms, September 6.

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[NOTE.—The references are to page-figures in brackets.]

APPENDIX D.

THE OYSTER.

XXI.—REPORT TO THE MINISTER OF THE MARINE RELATIVE TO OYSTER-CULTURE UPON THE SHORES OF THE BRITISH CHANNEL AND THE OCEAN.*

By G. Bouchon-Brandely,
Secretary of the College of France.

Monsieur the Minister: You did me the honor to charge me with the mission of ascertaining the condition of oyster culture upon the the coast of the English Channel and the ocean.

I return from this mission with the profound conviction that this new industry, so peculiarly French, has, after some unsuccessful attempts in the beginning, arising from the novelty of the enterprise, entered upon a stage of development and progress so well defined that we dare affirm nothing can arrest it.

The ever-increasing demands of consumption, stimulated by the promptness and facility of traffic and the more general diffusion of wealth, have engaged public attention for more than thirty years.

Agriculture was first to make the effort to supply these increasing necessities, but the ever-recurring demands for a sufficient food supply not permitting any of our natural resources to be neglected, the rivers and the seas have been placed under tribute and constrained to furnish their share. In a few years our coasts and our water-courses were exhausted. Then arose, as an economical question of the first rank, the necessity of repeopling the waters and placing the fisheries (*domaine de la pêche*) under regular conditions of production.

Such was the origin and *raison d'être* of pisciculture and oyster-culture, two industries which have been created in our own time.

Previously, in 1872 and 1873, M. the Minister of Public Instruction had confided to me the double mission of studying fluvial pisciculture in France and abroad. I had occasion to recognize and to note with regret that while in many neighboring states the main rivers and their tributaries were being successfully restocked with fish, in France, where pisciculture originated and where it had its first scientific laboratory, and where the six hundred water-courses which furrow its surface afford a working field of not less than 600,000 hectares, it was not an object of regular or general pursuit. To-day we may, with some pride,

* *Rapport au Ministre de la Marine relatif à l'ostréiculture sur le littoral de la Manche et de l'Océan, par M. Bouchon-Brandely, Secrétaire du Collége de France. Extrait du Journal Officiel des* 22, 24, 25 *et* 26 *janvier* 1877. *Paris, Librairie des publications législatives. A. Wittersheim et Ce, Quai Voltaire,* 31, 1877.—Translated by Marshall McDonald.

point these people—our masters in the art of cultivating the waters—to the progress which oyster-culture has made upon our coast.

Undoubtedly the cultivation of the oyster was practiced long ago, and wherever this shell-fish holds a position more or less important as a food resource, its artificial rearing has engaged attention, but it has not become, as with us, a systematized industry.*

It is fitting I should declare that the Department of the Marine has dowered France with the industry of oyster-culture. To it belongs the credit of the first attempts and of perseverance in the enterprise, as well as the honor of the results to which this report bears testimony.

The idea of establishing special devices to arrest and preserve the spawn which the oysters permit to escape into the water during the period of gestation is comparatively recent. It originated with a distinguished officer of your administration, who has given to it practical realization.

In 1851, when M. Coste visited the oyster establishments of Lake Fusaro and found in progress there some timid and irregular attempts at oyster-culture, M. de Bon, then Commissioner of the Marine and chief of the service at Saint-Servan, was engaged in the re-establishment of the oyster-beds at the mouth of the Rance and in the roadstead of Saint-Malo, by means of oysters brought from the natural beds in the Bay of Cancale. He carried on these attempts with great perseverance and his efforts were crowned with success. He demonstrated a fact of the greatest importance to the new science, and which up to that time had been doubted, viz, that the oyster was capable of reproducing itself in locations which were laid bare at low water (*terrains émergents*), and that it was possible to obtain a harvest of spawn from them. To confirm this discovery M. de Bon himself established a *parc* for experimental investigation, in which he conducted a series of experiments to ascertain the best means of securing the spawn. He devised apparatus for collecting it, and very soon he forwarded to the minister a spawn collector of his invention covered with young oysters. A detailed report accompanied it and afforded a demonstration that was unanswerable.†

The complete success of these experiments was announced by M. Coste in a report dated February 5, 1858, and inserted in the *Moniteur* of the 28th of June following.

It is proper here to give an account of the part borne by M. Coste, professor in the College of France, in the inauguration of the new industry.

In traversing the coast upon a mission of the Emperor, who had directed him to conduct a series of experiments in regard to marine pisciculture, this illustrious embryologist visited Saint-Servan in the month of August, 1857. There he found the cultivation of the oyster

* Report of M. de Bon, Commissary-General of the Marine, on the condition of oyster culture in 1875.

† See the note inserted in the *Moniteur Universel* of October 8, 1859.

begun. He saw the decisive results obtained by M. de Bon as well in the restoration of the natural beds as in the securing of spawn. Here was the practical confirmation of his theories, and, moreover, the revelation of the means of carrying them into effect, which he was still seeking for. His lively imagination was filled with enthusiasm at the discovery of M. de Bon. To popularize it he brought to bear the prestige of his high position in the College of France, his distinguished reputation, his scientific knowledge, and the declared support of the head of the state.

Means of action were placed at the disposal of M. Coste, and considerable sums of money were devoted to attempts at restocking upon a vast scale. Private industry demanded to share in the movement and followed the impulse given by the Government.

We know what bitter disappointments attended these first attempts. They seemed to compromise forever the future of the oyster industry. But the administration of the marine was awake. The control of it passed into the hands of M. de Bon, who had taken to heart the success of the enterprise, and who never lost courage.

The strict observance of the decrees of 1852 in the conduct of the fisheries may be regarded as having contributed largely to the actual prosperity. These decrees, the wisdom and opportuneness of which the event has demonstrated, were intended to stop the spoliation and exhaustion of the oyster-beds and to subject their exploitation to strict and rational regulations.

These decrees M. de Bon had prepared the way for by his reports and his experimental researches.

The persevering application of these measures, the care unceasingly renewed, the encouragements and the example, which the administration of the marine continually gave, resulted in bringing about the restoration of the natural beds, which were approaching exhaustion, and in provoking a revival of oyster-culture by private individuals.

These, deriving instruction from their own observations and the experiments conducted by the state, have improved and almost perfected their methods. After a rapid revival, we now find this industry yielding remunerative returns to those engaged in it, and not without profit and honor to the whole country.* But we must not forget that administrative guidance is as useful now to assure its success as the solicitude and the encouragement of the state have been necessary in the past to prepare the way and guide its first steps.

In the course of this report I will doubtless have occasion to state contradictory facts, for in practice divergences in the application of processes constantly arise. This is due to a variety of circumstances. Methods cannot be invariable; they must possess sufficient flexibility to adapt themselves to all natural conditions, and these conditions vary

* The number of persons who derive their support from the oyster industry may be estimated at 200,000 at least.

greatly with the region, the climate, the nature of the soil, the composition of the waters, the direction and strength of submarine currents, etc.

Doubtless some phases of this long practical study should be examined and studied separately, but in this report, the only object of which is to make known the condition of oyster-culture upon our coast, it is not necessary to disengage and discuss them. I will content myself, therefore, while making from time to time some observations, with stating my mission in the order I have accomplished it, and describing the industry in each locality just as I have seen it.

COURSUELLES-SUR-MER.—Situated in the vicinity of the natural oyster beds of the English Channel and the plantations of Dives, at the mouth of the river Seulle, from which it borrows its name, Courseulles is one of the points upon the coast of Normandy where the industry of oyster-culture is practiced with success and profit.

The oysters sent from this station have long enjoyed in the markets a well-deserved reputution. Nevertheless, Courseulles is not a place of production. The planters (*parqueurs*) who have established oyster ponds (*viviers*) there, possess, at Saint-Vaast-la-Hougue, bedding-grounds (*étalages*) devoted to the growth of the oyster, and the parcs at Courseulles are used only to fatten them and prepare them for market. The oysters handled there are generally obtained from the beds of La Manche where the fishermen collect them to sell to the dealers.

These oysters would not be held in such esteem by the consumer, if they were not previously subjected to a special training (*éducation*) which is the peculiar industry of the planters of Courseulles. This is designed to impart to them that delicacy of flavor for which they are famed, and the ability to bear transportation without losing their freshness.

The oyster parcs of Courseulles are excavated behind the sand hills, and have communication with the sea through the mouth of the Seulle.

Disposed in order along the banks of this water course, they communicate with each other by means of canals through which, twice in a fortnight, and for several consecutive days, the cool waters from the sea are borne in all directions.

Each parc is provided with a gate which serves either to retain the water or to empty the reservoir, when the tide runs down, and also gives passage to fresh water when it is necessary to fill the pond. In the last case the gate is not opened until the tide has risen above the level of the water in the reservoirs.

It is at this time that the waters are the purest; earlier they hold in suspension the mud stirred up from the bed of the river, and the earthy matters that the waves have washed from the banks.

The parcs excavated in an argillaceous soil, occupy an area of 15 or 16 hectares, a space which may be enlarged in the future. They are from 80 to 100 meters in length, 12 wide, and have a mean depth of 2 meters.

The sloping banks form with the bottom an angle of forty to forty-five degrees, and are covered by a layer of gravel two to four centimeters in thickness.

About the middle of August the oysters of Saint-Vaast-la-Hougue begin to arrive at Courseulles in quantities as needed by boats appropriated especially to this work.

Only those are brought which are of the prescribed size, since, from the lateness of the season, as well as the nature of the formation in which the ponds are excavated, it is not expected that they will increase much in size in their new home.

Before leaving La Hougue, and, again after arriving at Courseulles, they are washed, assorted, and carefully cleaned from the mud and the marine plants which are attached to them, and from all parasites which may mar the beauty and regularity of the shell or depreciate its value.

The process of training (*éducation*) is very simple. The subjects are left to recover from the fatigues of the voyage. Then those which are to be sent first to market are spread evenly on the shelving sides of the reservoir. With the aid of a rake, or even by hand, the rest are scattered over the clayey bottom and remain there for a time, when in their turn they are transferred to the sloping banks.

It is necessary to accustom the oyster to do without fresh water, and for as long a time as possible to hold the water retained in the shell. To accomplish this the oysters are left uncovered by the water morning and evening. The first few days the duration of the exposure is only half an hour or an hour, but the period is increased by degrees until, after some time, the oysters may remain exposed to the air the entire night.

By this time the oyster has really been taught to keep its valves closed, and may be transported long distances without opening or losing its freshness. As regards the fattening, this is not the object of any particular care. This condition occurs naturally at a certain period, and, moreover, the parqueurs attribute to the commingling of the fresh waters furnished by the Seulle with the salt water that peculiar disposition to fatten which characterizes the oysters of this locality.

During the summer and in the beginning of autumn the exposure out of water should cease a little before sunrise and be resumed in the evening after the temperature has fallen. At this period also the handling of the oysters should be repeated oftener to prevent them from becoming milky, which renders them unfit for consumption.

In winter, on the other hand, it is not so necessary to inure the oyster to this discipline of privation, and the continued handling is less indispensable. The temperature being lower, evaporation takes place less rapidly, and the mollusk does not feel the need of fresh water so often. But if the winter is severe and the period of frost threatens to last a long time, the oysters are sent back to La Hougue, where the parcs are less exposed to the frost.

Courseulles furnishes annually for consumption from 20 to 30 millions

of oysters. These are sold in conformity to a classification based upon their size; (1) *La grosse*, (2) *la marchande*, (3) *la belle*, (4) *la petite moyenne*, (5) *la perlot*. The price varies greatly and depends upon the success of the dredging.

GRAND-CAMP.—The station of Grand-Camp is not less favorable to the cultivation of the oyster than Courseulles, which is near by. But the rough sea and heavy surf renders impossible the establishment of parcs under ordinary conditions. It is necessary to overcome the difficulties presented, by engineering skill, a result successfully accomplished by MM. André (François) and Fébvre.

It will not be necessary to describe both of the establishments founded in 1874 by MM. Fébvre and André. Both were organized on the same principle. I will examine more particularly that of M. Fébvre, in the founding of which M. François André also co-operated. This establishment is situated upon sloping ground about one kilometer from Grand-Camp, upon the other side of the Downs. It covers an area of five hectares and is surrounded by high embankments which shelters it from winds and storms. It is divided into 32 parallel basins, which are for the most part 45 meters long, 15 wide, and 1½ in depth.

The sides are constructed of stone without mortar, and the basins are separated by roads for the convenience of the workmen. The service of each basin is completed by a wherry, which the employés manage with readiness. The water to supply the basins is admitted at the old Fort Samson, distant about 50 meters from the nearest parcs. It is stored in two reservoirs, and may be renewed at every flood tide. The water is conducted to the principal establishment through a subterranean canal, having a width and depth of about 1½ meters.

The distribution is regulated by means of strong gates, which at the same time serve to keep the reservoirs full when the tide runs down. A feed canal traversing the length of the establishment divides it into two parts, and provides for the supply of all the basins, each of which is furnished with sluice gates, by means of which the water may be either introduced or drawn off.

The parcs being established upon a gently sloping surface, and communicating directly with each other, a current through the interior may be produced whenever desired.

I should add that several small springs have their sources in the basins, and serve to temper the saltness of the sea water. The bottom of the parcs is a stiff clay.

Between Fort Samson and the establishment are erected the work rooms, where are conducted the different operations required in oyster culture, such as the singling (*detroquage*) of the dredged oysters, the sorting, packing, etc. In these operations fourteen women find occupation for almost the entire year.

What is the purpose of these 32 basins? What are the processes employed at Grand-Camp by MM. Fébvre and André in handling the spawn, and in the growth, fattening, and greening of the oyster?

The two semicircular reservoirs situated in Fort Samson, and which first receive the sea water, are devoted to the preservation of the spawn.

A part of one of these two compartments serves at the same time for some experiments undertaken by M. Fébvre in regard to the artificial fattening of the oyster according to methods employed by oyster-planters in America. These experiments have given no useful result.

The operations which precede the marketing of the oyster, viz, the washing and disgorging, are conducted in a basin lined with asphalt, in the principal establishment, which is reserved for this purpose.

Finally, in the other parcs the oysters are classed according to age and size. All the spawn treated at Grand-Camp is brought from Brittany. The young oysters begin to arrive in the month of April, and are at once placed upon metal trays 1 meter long and 50 centimeters wide; from 4,000 to 5,000 are placed on each. The use of these trays greatly abridges the time required to clean the spawn. To free it from the sea mud it is only necessary to take the tray by the two handles with which it is provided, and to agitate it gently in the water.

After a few months the growth of the oysters is such that it is necessary to double the number of trays. But the basins of Grand-Camp being too small to contain the number of oysters which M. Fébvre raises each year, a part of them are sent to Saint-Vaast-la-Hougue. The rest are inclosed in boxes having an area of two square meters, which are covered by wooden bars placed at intervals, so as to permit access of water.

These boxes are submerged in a parc situated near the shore, and in the vicinity of the establishment.

The oysters having attained a marketable size, they are, about the month of November, returned to the shore parcs (*parcs de terre*) and are either spread upon the bottom or upon the trays, in order to fatten them. The greening takes place at the approach of winter, at which time the basins are carpeted with a green moss, the appearance of which is the signal of the greening of the oysters, which takes place here as at Marennes.

The oysters sent from the parcs of MM. Fébvre and André rival in in quality and in form the very finest produced anywhere.

The shell, small, thin, translucent, and well rounded, recalls the oyster of Ostende, which they also rival in table qualities. What especially distinguishes the oysters of Grand-Camp is their resemblance in flavor to the oysters obtained from the natural bed of Guinehaut, which are held in such high repute. This bed is situated at the mouth of the river Isigny, and unfortunately produces very few.

To give some idea of the extent of the establishments at Grand-Camp, I would state that M. Fébvre is prepared at the present time to send to market three millions of oysters.

SAINT-VAAST-LA-HOUGUE.—From time immemorial the fishermen of Saint-Vaast-la-Hougue have coupled with their proper vocation that of

cultivating the oyster. But with the exception of some new oyster cultivators the most of the enrolled maritimes (*inscrits maritimes*) who farm (*exploitent*) the parcs granted by the state content themselves with keeping for a very short time the oysters obtained from foot-fishing (*la pêche à pied*) and from the dredging, to which, during the open season, the greater part of the population of this section devote themselves.

About the 1st of September the seafaring men betake themselves to the natural beds to fish for oysters. The foot-fishing is only productive at the time of the spring tides. It is pursued by women and children, who only obtain the oysters which have been torn from their natural beds by the violence of the waves.

The oyster grants of Saint-Vaast-la-Hougue, located on a miry-clay deposit, comprise both *dépôts* or bedding-grounds and parcs. The first, to the number of forty-eight, occupy an area of 46½ hectares, and extend over that part of the seashore called Couleige. These are reserved for the young oysters which have to grow before attaining merchantable dimensions. The second, which are appropriated to the preservation of eatable oysters, are situated in the Toquaise, and are, for the most part, sheltered from the sea by the little island of Tatihou. They number 137, and occupy an area of 39½ hectares.

The *dépôts* or bedding-grounds are only uncovered during the spring tides. They are inclosed by walls of loose stone from 15 to 25 centimeters in height.

The parcs are also inclosed with walls of loose stone from seventy-five centimeters to one meter in height, and have a thickness of from two to three meters.

Upon the approach of winter, after the small oysters from the bedding-grounds have been transferred to the parcs, in order to shelter them from the rigors of the cold season, a layer of clay mixed with straw is rammed into the interstices of the walls, which prevents the water from draining out of the parcs at low tides, and the volume of water which covers the oysters shelters them from the influence of the cold air and protects them from freezing. The expense of maintaining these walls is borne equally by the riparian proprietors. The bedding-grounds (*dépôts*) and the parcs are cleaned once or twice a year. This is necessary in order to remove the slime that the sea has deposited, and the marine vegetation which has invaded them.

The oysters which succeed best in cultivation come from the Bay of Cancale, or the natural bed of Dives; nevertheless experiments made with the oysters of Arcachon and Brittany have given good results.

The cultivators of La Hougue are of the opinion that the parcage of the oyster should not be prolonged beyond two years. The first year they grow 3 or 4 centimeters. During the second the rate is slower, but the oyster grows thicker and fattens. Indigenous oysters, or rather those obtained in a very circumscribed radius, may be kept a longer time.

The processes of cultivation employed at La Hougue consist chiefly in cleaning, and frequently shifting the oysters to prevent them from being buried in the mud, or covered by parasitic growths, which by attaching themselves to the valves prevent them from opening, and finally cause the oyster to perish by stifling it. These manipulations are repeated two or three times a month in the parcs, and oftener if made necessary by the quantity of sediment deposited by the sea, or by the abundance of the marine vegetation.

During the winter it is not so urgent to repeat the manipulations so often, for independent of the difficulty of such operations at this season, the marine confervæ, the presence of which in the parcs constitutes a serious danger, have disappeared.

The young oysters placed in the *dépôts*, to attain their growth, are not, during the six or seven months they remain there, the object of any treatment. The *dépôts* being situated at some depth in the sea, the water which covers them is purer, and the marine algæ are less abundant.

The only attention required is to wash them when they are transferred to their winter quarters, and when they are removed from them.

I should record here an observation made by some of the oyster planters of Saint-Vaast-la-Hougue. They observed that certain parts of their planting grounds became unsuitable for the purpose, and seemed to be exhausted. To remedy this condition of things they adopted the plan of allowing those portions to lie fallow (*de mettre en chômage*) for a year, to the end that these water fields might have time to improve and return to their first condition. I may add that they have had every reason to be satisfied with the results of this method.

Too many questions are involved in the consideration to permit us to study fully the many causes which contributed to bring about this exhaustion. The two principal ones seem to be the following:

1st. The allotment of too many individuals to one parc.

2d. The constant shifting of fetid mud derived from the decomposition of vegetable matters, which is borne by the water in all directions.

In the first case the oysters receive insufficient nourishment; insufficient, because if in a certain volume of water which can furnish sufficient food for only 1,000 oysters, we place 50,000, starvation and disease must be the result.

In the second case death is directly the result of poisoning; but I am free to declare that this condition of the parcs of La Hougue is much exaggerated; nor is there anything alarming about it.

On the contrary, I am happy to give the assurance that the importance of the oyster industry is constantly on the increase. Many abandoned parcs have been taken up again and are being cultivated with profit. It is sufficient to say that 300 persons find occupation each day in the concessions of Saint-Vaast-la-Hougue, and at each spring-tide this number is at least doubled.

GRANVILLE.—It is upon that part of the French coast washed by the

British Channel, and between Saint-Malo, Cancale, Granville, and Regnéville, that the most productive natural beds of oysters are found.

In the neighborhood of Granville alone we may count eleven natural beds of oysters ["Oyster rocks," Chesapeake Bay.—TRANS.], viz: Foraine, Haguet, Trou à-Girou, Saint-Marc, Bout-de-Rive, Saint-Germain, Géfosse, Sénéquet, La Costaise, Le Ronquet, and Le Pirou.

It would be difficult to estimate the number of the inhabitants of this coast who live by the oyster fishery. It is quite large, but within the last few years has sensibly diminished, for the reason that the fishing is less productive than formerly.

With the view of competing with the English oystermen in the working of common waters, the proprietors of the beds of Granville and Cancale were authorized to depart from the rule which prohibited them from remaining in their boats after sunset. The result has been that, under the pretext of dredging concurrently with the English on common grounds, they have found it more profitable to plunder the reserved beds of the territorial sea, and have ruined them. Wise measures have been taken to prevent a recurrence of these depredations.

By means of strict supervision, and through the discretion allowed the maritime administration to prohibit fishing at any point for one or two years, if the necessity of it has been recognized by the commission whose duty it is to ascertain the condition of the oyster beds; and, lastly, by means of the state reservation, where fishing is absolutely prohibited, and from which the spawn is scattered in every direction, these oyster beds have been re-established.

In fact, this work of restoration could not have been accomplished in so short a time, allowing for the extraordinary fertility with which the oyster is endowed, did not the places which receive the spawn present the conditions indispensable for its development.

These conditions are not always found upon grounds which have been exhausted by unrestrained fishing. In such cases suitable conditions must be created or re-established before we can expect success. The industry of oyster-culture proper is carried on at Granville in 85 storage parcs (*parcs de dépôts*), which serve only to shelter the oysters fished from the neighboring beds until the time when the cultivators of Courseulles and La Hougue, who usually obtain them, come to take them away. They are all inclosed by a double wall of wicker-work, from 70 to 80 centimeters in height. The interval between the two walls is filled with clay, kneaded up with straw or simply with mud.

This arrangement has for its object to prevent the oysters stored in the parcs from being displaced and dispersed by the impulse of the waves, and at the same time retain the water at low tide, and thus protect the oysters from the injurious effects of heat or cold.

I should add that the sea is so often rough at Granville that although there are in the immediate neighborhood inexhaustible centers of repro-

duction, it would be extremely difficult to fix collecting apparatus along the shore.

REGNÉVILLE.—Although but a short distance from Granville, the station of Regnéville is very favorable to the cultivation of the oyster.

Near the apex of the angle formed by the Norman coast and the coast of Brittany opens an immense harbor, which, commencing at Point Agou, extends along the shore upon which Regnéville is built. The swell of the ocean fills it at each tide.

The Sienne, a small stream of fresh water, having its sources in La Baleine, empties into this bay and mingles its waters with those of the sea, tempering their saltness and giving them those precious characteristics so sought for by cultivators, and which I have already referred to in speaking of Courseulles.

Just below the mouth of the Sienne is situated the oyster-cultural establishment founded by Madame Sarah Felix, of which I shall give a brief description. I will barely refer to the ancient parcs now disused, since the fishermen carry elsewhere the fruits of their fishing, and the bedding grounds (*dépôts*), more ancient still, which were called "The parcs of the river Passevin", and which are now abandoned. These bedding grounds were arranged in the same manner as those at Courseulles, and served only to furnish an asylum for a longer or shorter time to the oysters collected by the fishermen of the country, which passed into the possession of the proprietors of those planting grounds. They were fed through a subterranean canal communicating with the sea, and admitting the water only during the spring tides.

Before Madame Sarah Felix established herself there, no serious attempt at cultivation had been undertaken at Regnéville.

The parcs of Madame Sarah Felix are excavated in a calcareous formation, and occupy an area of 5 hectares. A secure dike, 6 meters in height, constructed of the earth removed from the basins, intermingled with large stones, protects them from the assaults and the violence of the sea. The side facing the water is revetted with large bowlders, against which the waves spend themselves, and which can be neither undermined nor displaced.

The water is introduced by means of an open canal, which starts from the level of low water. Upon reaching the establishment, the water is received and distributed through a large gate, moved by geared wheels. The bottom of the opening is several feet below the level of high water during the neap tides. It was indispensable to adopt this arrangement in order that only perfectly pure waters might be permitted to enter the reservoirs after the tide had attained its greatest height. There is around the whole extent of this harbor a vast amount of calcareous sand, which is lifted by the rising tide and swept along by the currents.

A principal supply canal traverses the establishment and distributes the fresh waters into 24 basins. The depth of these basins is about $3\frac{1}{2}$ meters, and the depth of water in them about $2\frac{1}{2}$ meters. Each division

communicates with the canal through a small sluice gate, which serves to admit the water and to retain it when required.

Quite a large spring rising within the limits of the property gives the means of tempering the saltness of the sea water.

What results have been obtained in these parcs of Regnéville?

After a number of preliminary experiments had demonstrated the possibility of carrying on successfully the growing and fattening of the oyster in the parcs that had been organized, Madame Sarah Felix undertook, in 1865, some experiments upon the reproduction of oysters in confinement.

Adult specimens, taken from the bed of La Costaise, which furnishes the finest and most esteemed products of this section, were placed in a compartment, in which was arranged collecting apparatus made of boards and also of tiles. At the usual time the oysters emitted their spawn, which attached itself to the collectors. The result was not completely successful. It was learned during the progress of the experiment that the basin lacked sufficient depth, and that the waters were not sufficiently renewed. The experiment was, however, very encouraging. A large number of the young oysters, which they were successful in preserving and which remained attached to the collectors, exhibited a rapid and marvelous development.

Shortly afterwards, new experiments were made with one hundred thousand oysters. Oyster-culture was then in its inception, and they had not yet learned how to coat the collecting apparatus in order to facilitate the removal of the oysters which became attached to them. In order to remedy the difficulties which had been experienced, the tiles were covered with paper which had been coated with a thin layer of cement. By this device the removal of the oysters was readily accomplished. Moreover, by suitable arrangements, a regular and ample supply of water was secured in the basins.

Success was complete. The collectors became loaded with young oysters; their removal was easy, and the subsequent development of this new generation, born in the parcs of Regnéville, was accomplished under the most advantageous conditions.

For some time afterwards, the parcs, the maintenance of which involved costly labors and continued repairs, were on the point of being abandoned. In 1873, Mr. Vallé placed in them, to grow and fatten, 83,000 young oysters, originally brought from Vivier-sur-Mer, and having a mean diameter of from 2 to 3 centimeters. A year later, 65,000 of these were sold, having then attained a diameter of 7 to 8 centimeters. Since this period, Madame Sarah Felix has made some improvements which she has decided upon, so that fresh water can be introduced into the establishment at all stages of the tide. This was not practicable before the level of the gate had been lowered and the basins excavated to a greater depth.

There is every reason to think that, with these well-planned improve-

ments, this fine establishment, the first of its kind, will respond to the legitimate expectations that the first successes had awakened.

I will conclude by repeating the opinion which I expressed in the beginning, viz, that the station of Regnéville presents all the requisite conditions necessary to make it an important center for oyster-culture, not only from its situation, but because it unites all the natural elements for the successful prosecution of this industry.

The extent of surface which may be put to use is very great, and the cultivation of it would prove easy and lucrative.

CANCALE.—Among the products of oyster-culture most highly esteemed, the oysters of Cancale occupy the first rank. They are distinguished as well by their fine flavor as by the good shape and depth of their shells. The animal is thick without being too large. It keeps fresh for several days out of the water, and holds for a long time the sea water which the valves inclose. These qualities are due to its origin and to the variety of the oyster as much as to the methods of cultivation.

The processes of education pursued at Cancale are very nearly the same as those employed by the cultivators of La Hougue.

The oyster beds of the Bay of Mont-Saint-Michel, whence these delicate oysters are obtained, are the most productive of beds of the British channel. They comprise the beds of Corbière-ô-les Chaudières, Le Bas de l'Eau, Le Vivier-ô-le-Mont, L'Orme-ô-le-Moulin, called La Raie, Saint-Georges, Le Beauveau-ô-le-Mont, and finally the reservation made by the state, and which serves to separate the beds of Granville from those of Cancale.

Cancale is not only a place of deposit. All the processes of cultivation are carried on there, from the period when the oysters are gathered by the fishermen from the beds in the open sea, or gleaned upon the strand, to the time when, their education completed, they have acquired those qualities which make them sought for for the table.*

The concessions granted cover an area of 172 hectares. This is divided into 1,276 parcs and bedding grounds (*étalages*). The latter are situated low in the sea, and each season their walls of wicker work are covered with spawn. In these are placed the small oysters the dimensions of which do not permit their being sent to market. The oysters which have attained marketable size are placed in the parces and remain there until they have completed their preparation for market.

All the concessions are fenced in by a double row of palisading, which shelters them from the destructive effects of the strong currents.

Throughout the whole bay of Mont-Saint-Michel there are two ever-

* By the terms of the regulations concerning oyster fishing, individuals taken upon the natural banks, and which have not attained the required dimensions of 5 centimeters, must be thrown back into the sea. When the fishing is over, the oysters are sorted, the smallest being placed in the parcs. It is the same with the oysters picked up on the beach by the foot-fishermen (*pêcheurs à pied*).

imminent elements of destruction, against which the cultivators must continually struggle: the winds and the mud.

The winds from the ocean—the violence of which is such that often the oysters are shifted from one parc to another or scattered in the tide-ways—blow usually during the winter, and necessitate the exercise of incessant daily care to maintain the planting grounds in good condition, the incursions of mud and sand being increased by the roughness of the sea. At each tide, when possible, the cultivators must visit their parc and proceed to the cleaning, the necessity for which is constantly renewed.

Four thousand persons are employed each day at this work. The oysters never remain more than two or three years at Cancale. This period of time is sufficient to give them the development necessary before sending them to market.

Moreover, it is not to the interest of the cultivators to keep them for a longer time.

Besides the oyster merchants, properly so called, who profit by the provisions of article 338 of the decree of July 4, 1853, in order to obtain grants, many of the enrolled maritimes, in consideration of the abatement of rent by the provincial administration, pursue the oyster industry upon their own account. The poorest content themselves with keeping for one season the oysters they have gathered from the beds, or which their families have collected along the shore. Before the administration of the marine had put in force those protective measures which are the safeguard of our oyster beds, the foot-fishing (*pêche-à-pied*) was becoming each year more unproductive. To-day it is prosecuted by companies of from 500 to 1,000 persons, women as well as children, who find in it an assured means of subsistence.

It remains for me to say a word in reference to the attempts made under the auspices of the administration to collect, in spite of the violence of the sea, the spawn which is each season thrown out from the oyster beds.

The parc which the administration has devoted to these experiments is 40 meters square. The side which faces the open sea and the opposite side are completely open, in order to give free access to the waters freighted with spawn. The other two sides are protected by palisades.

Tiles arranged in bunches, fascines of birchwood, and slabs of schist are all employed as collectors. The spawn arrested in great abundance, but by the time winter comes the violence of the sea has succeeded in displacing the larger part of the generation which had established itself.

The end sought by the administration, viz, to demonstrate that the spawn is just as abundant at Cancale as at Le Vivier, has been attained. The rest will be accomplished by private enterprise.

It is hardly necessary to state that the measures of surveillance instituted by the department of the marine for the preservation of our oyster beds have also served to shelter the parcs from the cupidity of maraud-

ers. In addition to the usual police supervision exercised by the agents of the administration, seven guards, paid out of the funds derived from the rents of concessions, two general guards, who receive an allowance from the funds of the society of fishermen, and four sworn guards, appointed and paid by the marine, are charged with this service.

Moreover, a syndicate, composed of the commissioner of maritime inscription, as president, the mayor of Cancale, the inspector of fisheries, the syndic of seafaring men, the cashier of the society of fishermen, and two of the parc guards (*un garde-parc et un garde d'étalage*), determine each year the assessments to be paid by those holding concessions, and the amount thus obtained is appropriated to the common expenses, such as the wages of the guards, the repair of roads, channels, etc.

In conclusion, I have had the satisfaction of learning that almost all the grants are now being worked. Ten years ago more than half of the parcs were abandoned.

LE VIVIER-SUR-MER.—The parcs of Le Vivier-sur-Mer were founded only seven years ago, under conditions analogous to those existing at Cancale. Before this, fishing was almost the only water industry familiar to the inhabitants.

The beach of Le Vivier greatly resembles that of Cancale. There is the same miry soil, only a little more calcareous, the same rough sea, and the same difficulties to overcome in order to protect from the violence of the waves. But the methods pursued are different, Le Vivier-sur-mer being more particularly engaged in the propagating of the oyster.

Development upon the collecting apparatus succeeds there, however, and it would seem that this shore is even more favorable for the rapid development of the mollusk than that of Cancale.

Before giving the details of the methods of cultivation of the oyster, I will recall briefly the circumstances under which oyster culture originated in this locality.

The experiments upon reproduction made at different points upon the coast attracted the attention of certain persons, who attempted to capture the swarms of embryos (*flot de semence*) which the oysters emit in the spring, and which up to that time were wasted in consequence of being smothered upon the muddy bottoms.

The first collecting apparatus placed upon the strand of Le Vivier belonged to M. Barbet. It consisted of slabs of schist and of hedges of wicker-work, running in the direction of the currents. This first attempt was quite successful. The year following, M. Meury de Villers, having obtained from the Minister of the Marine, who gave every encouragement to the experiments, the grant of one hectare of land, constructed parcs, and placed in them logs, resting upon which, in an inclined position, were slabs of schist of a size large enough to resist the force of the currents. Hedges of closely woven basket-work, from 3 to 4 meters in length and 60 centimeters in height, completed the arrangements. This year spawn was abundant, but when the cold and the

frosts came, the sea, urged by the impetuous winds of winter, bore off part of the harvest. The disaster was augmented by the frosts.

Only the oysters attached to the under side of the slabs of schist were spared. They produced specimens remarkable for their form, their quality, and their development.

Many other persons saw in this first essay reason for hope rather than discouragement. The sea, though often disturbed, was not always turbulent, and the frosts rarely occurred at the same time as the spring tides, the only ones by which the parcs of Le Vivier were exposed. New grants being asked for and obtained, the shores of Le Vivier were rapidly covered with parcs.

The winter of 1870–'71, of such unhappy memory, was even worse, and almost put an end to the infant industry. The collectors retained so little spawn that many of the cultivators abandoned the work. But succeeding years brought fruitful compensation, and this oyster-cultural station, born but yesterday, has to-day a promising future as a place of reproduction.

The *parquage* of oysters is very difficult, if not impossible, at Le Vivier, and they are left upon the collecting apparatus to grow until they are ready to be sent to market.

The only collectors used are bundles of twigs and slabs of schist. Madame Sarah Felix, however, has found it profitable to replace the old system by a new apparatus, consisting of sheets of roofing slate, which usually are kept immersed from the middle of June to the middle of July. The fascines require to be often renewed, for they are rapidly destroyed by the sea. Moreover, the barnacles, which are very abundant in these parts, cover them in the spring and render them unsuitable for the spawn to settle upon. These parasites are not the only enemies to be combated. The mussels, much more to be dreaded, are scattered over the parcs of Le Vivier in such abundance as to form a layer from 15 to 25 centimeters in thickness. They have here neither the time to bury them, as is done in the island of Oléron, nor to collect them, though they are edible. The reason is that the parcs of Le Vivier are situated at some depth in the sea, and being uncovered only during the spring tides, the period of low water is employed in detaching the oysters upon the collectors, in gathering those lying loose upon the bottom, and in removing and repairing the palisading. It is difficult, in the short interval when work is possible, to collect laborers enough to meet the most urgent demands.

The number of oysters contained in these parcs is estimated at 5,000,000. The number is certainly small; but we should not forget the consequences of the winter of 1870–'71, and the discouragement which was the result of it, and we should remember that ten years ago Le Vivier-sur-Mer was absolutely unknown as an oyster-cultural station.

As regards the growth of the oyster, it is truly wonderful, and in the

course of my investigation I have seen only one station, Les Sales d'Olonne, which can be compared with it in this respect.

I have myself detached from a fascine an oyster fifteen or sixteen months old which did not measure less than 7.08 centimeters.

It remains to describe briefly the happy transformation effected by M. de le Gervinais. He made use of a mill-pond, fed at each tide by sea water. Into this he introduced oysters to attain their growth. The pond also received the waters from a small brook of fresh water. The development of the shell and the corresponding growth of the animal were without precedent, and they were attributed not only to the introduction of the fresh waters, the influence of which was of course favorable, but also to the abundant nutritive elements brought down by the brook.

Fosse-Mort, near Saint-Malo.—In 1878, M. Camac obtained from the Minister of the Marine a grant of three hectares, situated upon the river Rance, near Ménéhic.

The Rance formerly contained several oyster-beds, and recently, as I have stated already, M. de Bon has succeeded in re-establishing them.

In the beginning M. Camac succeeded badly, but the more difficulties multiplied, the more resolutely M. Camac, who is an American, exerted himself to overcome them.

The upper part of the concession rises like an amphitheatre, and is 150 or 200 meters from the bed of the river. The sea covers it at every tide, except during the neap tides. Here were excavated claires, 40 meters long, 10 meters wide, and 60 centimeters in depth, which served for the first experiments. The oysters and the spawn employed were brought from Auray. Upon arriving, the young oysters still attached to the collectors were detached and placed in frames made of galvanized-iron wire, which were placed in the claires. They made no progress during the whole summer, and the cold of winter destroyed the most of them, while oysters eighteen months old, inclosed in similar frames and lowered into the sea, developed to very good proportions. In October the frames containing these oysters were transferred to the upper ponds, which are, as I have already stated, covered and laid bare by almost every tide. There they quickly fattened and became green, but when winter set in disease invaded them. It was no better in the succeeding summer, and of the 15,000 started with, hardly 3,000 survived. This succession of reverses was fruitful of suggestions, which did not escape the attention of M. Camac. He at once concluded that the more elevated part of the concession did not afford the conditions necessary for the growth of the mollusk.

After attempting, without any better results, to change the form of his boxes, he decided, the following year, to transfer all of his oysters to the borders of the river, at a point which is uncovered only during the spring tides, and where the water is 30 meters deep (*à 30 metres de profondeur*) during high water. At the succeeding spring tides he found

that the oysters had made sensible improvement, and in October had acquired dimensions he was far from expecting.

In the year just passed 3,000,000 of fry have been brought from Auray to Fosse-Mort. They were placed in the claires without being removed from the tiles, and remained there until April of this year, when they were detached. Then the young oysters were placed in 350 nursing-trays (*caisses ostréophiles*) established in the lower part of the concession. Each month the trays are overhauled and thoroughly cleaned from the sediment which has settled over the interior, and from the marine vegetation which, by attaching itself to the wire gratings, impedes or prevents the free circulation of water. By the last of August of the current year the shells had attained a diameter of from 2 to 2½ centimeters. In spite of the losses incurred in previous years, M. Camac expects to market this season from 270,000 to 300,000 oysters having a diameter of from 7 to 9 centimeters.

Fosse-Mort belongs, both by its methods and its climatology, to the Normandy group of oyster-cultural stations.

Were I to attempt in a few words, before passing to the coast of Brittany, to convey the impression made upon me by the establishments already passed in review, I should say that each seems to supplement the others.

Each corresponds to one of the phases in the cultivation of the oyster. Le Vivier produces spawn, Grand-Camp busies itself especially with the early growth of the oyster, the maturing and fattening engages La Hougue and Cancale, and Courseulles trains them to bear transportation.

BREST.—The maritime province of Brest contains the largest number of natural oyster beds. But here, as elsewhere, these beds were at one time wellnigh exhausted by the improvidence and cupidity of the fishermen.

In the roadstead of Brest alone, where there were formerly twenty-seven oyster beds, there are to-day only seventeen, as I learn from official documents obligingly communicated to me by Commissary-General Dauriac, and of these there are but six in which are found any evidences of reproduction. This condition of impoverishment, well advanced in 1857, attracted the attention of M. Coste, who, with the view of remedying it, caused a large number of fascines to be immersed in the bay. The sea swept them all away, and the attempts were abandoned.

Is it right to say that the fishermen were the sole authors of this ruin? Doubtless they were chiefly concerned in it. But natural conditions concurred to render it complete. At one period the boring whelks (*Bigorneaux perceurs*), MUREX, which are so destructive to the oyster, invaded most of the oyster-beds of Brittany, and did incalculable damage; some of them were utterly destroyed.

In the roadstead of Brest another cause has co-operated with those already mentioned. In some years the bottom is covered with a red

sea-weed, the presence of which exerts an injurious influence upon reproduction.

However, every disaster has its compensations. The same conditions which covered the bottom with sea-weeds established beds of broken coral in the vicinity of the old beds. Subsequently young oysters were found attached to the branching stems of coral brought up from the bottom.

This fact is full of promise, either for the restoration of the old beds or the establishment of new ones. We should not forget that the supervision of the oyster beds is very difficult in this little sea. The roadstead of Brest has not less than forty miles of coast line. This is broken by numerous creeks, in which the marauders, signaled by their confederates who are on the watch, find refuge from the pursuit of the fishery guard. Being provided with boats of very light draft, and possessing a perfect knowledge of all the creeks and coves, they quickly take refuge where the government vessels cannot follow them.

The administration of the marine has exerted all its influence to persuade them that to fish without restraint is to destroy the harvest that the future would yield, but the facilities offered by the railroads for the quick sale of the fruits of these marauding expeditions have caused these wise counsels to be disregarded. The measures of coercion employed to repress their rapacity have likewise proved ineffectual. Such was the condition of things a few years ago; at present it is a little better. Moreover, the number of marauders is not so large, for they do not now find in the pursuit of their unlawful industry the means of subsistence.

As regards oyster-culture, the roadstead would seem to lend itself in a marvelous way to the operations for which this industry gives occasion. Yet the sea is very rough during the stormy season, and swift currents traverse it in every direction. We recall, too, the unfortunate experiments made by M. Coste in 1857. Since that time no one has sought to bring into cultivation this splendid expanse of water which apparently is so tranquil.

In 1874, M. Thomas, an engineer, a man of strong convictions, and imbued with novel ideas in regard to collecting the spawn in deep water, and in regard to the development, growth, and *parquage* of the oyster, obtained from the Minister of the Marine the grant called Le Moulin-Blanc. This part of the bay receives a small stream of fresh water, which may be utilized with advantage. M. Thomas established parcs and stocked them with oysters. The experiments undertaken were based upon views peculiar to him. They are still too recent for us to form an estimate of their result. Up to the present time the experimenter has worked at it rather as a scientific question than a business enterprise. He has studied the roadstead of Brest, its waters, their usual temperature, the winds that ordinarily blow, and the direction of the currents; every influence, favorable or otherwise, which may affect

results. He carefully records the observations of each day, and I entertain the hope that such painstaking endeavor will not be lost, either to the conscientious experimenter or to oyster-culture.

BÉLON, NEAR QUIMPER.—The establishment created by M. de Mauduit and M. de Solminihac in the river Bélon is one of the most interesting I have visited during the progress of my mission. The grant embraces about 5 hectares. It extends along the right bank, and borrows from the other shore an extensive estuary, shaped like a horseshoe.

I have rarely seen oysters artificially grown, or even taken from the natural beds, of so beautiful a shape or of so exquisite a flavor. The shell is fine grained, thin, translucent, hard, and the interior surface is pearly, whilst the exterior exhibits sharply defined but delicate dentations, which are the characteristic indications of the vigorous growth and perfect health of the animal inclosed.

Many things concur to assure to the establishment a high price for its products. These are the exceptional situation of the establishment, the favorable nature of the ground, the influence of the currents, the composition of the water, and the continual intelligent care bestowed upon the oysters under treatment.

Situated at 4 kilometers from the common mouth of the rivers Pont-Aven and Bélon, the parcs of M. de Mauduit and M. de Solminihac are constantly bathed by the living waters of the ocean, which are aërated by dashing against the cliffs which guard the shores of this wild and picturesque coast. Their situation offers the same advantageous conditions as the bottom of the open sea, where are the natural beds of oysters, and they are moreover sheltered from the violence of the tempests.

The bed of the river is composed almost entirely of shell sand, very rich in lime. The ebb and flow of the ocean keeps the water in incessant motion and establishes perpetual currents. The grant is divided into:

1st.—Parcs furnished with frames containing the fry, and which are only uncovered at the spring tides. These are for the most part situated in the deeper parts of the river.

2d. Parcs in which are placed the merchantable oysters either to grow more, or to fill out and to fatten. The bottom of these is every year covered with a layer of shell sand, containing about 80 per cent. of calcareous material.

3d. Submersible basins receiving water at every tide. These are designed to shelter the frames during the winter, and also serve as *dèpôts* for the oysters being prepared for shipment. These basins communicate with each other and can be readily emptied and cleaned at low water.

4th. A large reservoir constructed in a bend of the river and not subject to overflow, in which are contained other frames or pits walled with

cement, which are suitable for the storing and the cultivation of the oyster.

The spat (*naissain*) is brought from Auray from the breeding ponds (*parcs de reproduction*) which MM. Mauduit and Solminihac have established at Fort Espagnol. Upon its arrival it is emptied into the nursing frames, which are supported at a distance of 25 or 30 centimeters from the bottom, upon stakes driven into the mud, or upon wooden frames maintained in position by stakes. The young oysters remain in the frames in the open sea from the month of April to the month of October, when they are transferred to the reserve basins to pass the winter.

The following spring they are evenly spread over the bottoms of the ponds appropriated to their fattening. The average growth of the oyster each year is from three to four centimeters; with the larger oyster it is not quite so much, but it never amounts to less than from 2½ to 3½ centimeters. The rate of growth also varies with the source from which they are obtained and with the ponds in which they are placed. The oysters which increase in size most rapidly are those brought from Quimper. Of the oysters obtained by dredging at Auray many become sulky and refuse to grow the first season, but during the following season they make up for lost time.

The oysters in frames are left undisturbed during the fine weather. In handling them often there is danger of injuring the new growth which forms during this period. Then, before consigning them to their winter quarters, they are passed through riddles in order to classify them according to their dimensions. The spawn and the small oysters obtained in dredging are subjected to this sorting, consequently all those in a frame have the same dimensions.

The oysters nearly ready for market are placed flatwise on the bottom and often displaced and cleaned. The workmen charged with this duty, at the same time fill up with sand the excavations produced by the washing of the water or made by the crabs, so that the shells rest upon a perfectly smooth, even bottom.

MM. Mauduit and Solminihac have made in their parcs some interesting observations which should find a place in this report. Where the object to be attained is the fattening of the oyster, they have observed that they do better the oftener they are handled. They have also noticed that the oysters in frames increase more especially in length and breadth, while on the other hand with those bedded in the ponds the increase is mainly in the thickness. Lastly they have demonstrated that the growth is more vigorous and sensible in proportion as the oysters are brought nearer to the channels where there are continual currents.

Attempts at propagation made in the upper parts of the concession and in the vicinity of some parcs filled with oysters have not been unfruitful. This season they could count upon each tile from 70 to 80 fry. MM. Mauduit and Solminihac began operations at Bélon only

five or six years ago, and in spite of the hesitation and the disappointments inseparable from first attempts they are prepared to market 2,500,000 of perfectly beautiful oysters and still retain 6,500,000 in their parcs. In fine, they have endowed their country with a model oyster-cultural establishment, and overthrown many prejudices by utilizing localities which a few years ago would have been considered unsuitable for the culture of the oyster.

LORIENT.—The natural indications at Lorient show that the oyster industry will prosper there.

The Blavet, or river of Hennebont, which empties into the roadstead, not long ago contained oyster beds the products of which were much sought after. It was evident therefore that the mollusk ought to find in this bay a medium suitable for it.

It is at Kermélo, upon the river Ter, at a point a little below Lorient, that the MM. Charles and M. Turlure have founded their establishments.

After having made unprofitable attempts to collect the spawn emitted by the oyster beds of the river Hennebont, the MM. Charles changed the character of their operations and directed their attention to the growing and fattening of the oyster.

The Ter is a river with muddy bottom. Of its moderate width there remains but a narrow channel at the low water of the spring tides. The available locations are therefore very limited. A storage pond situated a little above allows fresh waters to escape into the river as needed.

There were moreover formidable difficulties to overcome in order to render profitable this portion of the maritime domain. Before attempting to establish oyster plantations upon the soft, yielding mud, it was necessary to consolidate it. The MM. Charles succeeded in effecting the consolidation of the bottom by spreading over it a layer of sand and gravel.

M. Turlure has attained the same result by other means. Thinking that the labor necessary for consolidation would involve, in his concession, too much expense, he had recourse to a system of pits lined with cement, invented by M. Michel, engineer, by means of which he is able to utilize all that part of his concession laid bare at low tide.

These pits are 50 centimeters long, from 34 to 40 centimeters wide, and are arranged in rows, between which are intervals to permit the circulation of the workmen. The advantages secured by this arrangement are, that the oysters contained in the pits are protected from excessive heat by being always covered by a stratum of water from 10 to 12 centimeters deep, even when the surface is left bare at low tide.

The oyster-cultural society, of which M. Turlure is the superintendent, has sixty thousand of these pits. The number these receptacles can accommodate varies with the size of the oysters. Of the fry and oysters less than one year old they will contain 300. Of those in their second year, 150; and of those in their third year, 75.

The parcs of the maritime domain are not the only ones included in the establishment directed by M. Turlure. In rear of the workrooms and store-houses are two large basins lined with asphalt. These are 80 meters long and 21 wide, and are used for the reception of oysters and to prepare them for shipment. They are subdivided into seven compartments, in which the oysters are placed according to their size and their origin. These basins are connected with the river by a canal, and the water in them can be renewed at pleasure.

For some years this establishment has been of real importance. According to the statement of M. Turlure, there are in the parcs and in the river 10,000,000 of oysters.

The establishment of the MM. Charles, which I have previously described, is completed by other ponds excavated in the dune which separates the private properties from the public maritime domain. A supply canal leads from the sea to the ponds and carries the water necessary for the establishment, the distribution of which is regulated by a sluice-gate at the extremity of the canal. The water may be renewed nine or ten days out of every fifteen.

The basins are not all devoted to the same purpose. One is appropriated to oysters, which are being subjected to the disgorgement which is usual previous to shipment. The others contain the frames and trays with open wire bottoms in which are placed the fry, or more frequently the oysters which are nearly ready for the table. These same areas of water serve during the winter to shelter the spawn bred in the river, and which it is necessary to protect from the cold.

The reservoirs communicate with each other, but, although supplied with the same water, they give very different results.

In one of them, that most remote from the mouth of the canal, the bottom of which is composed of mud and clay, the oysters readily increase in dimensions from 4½ to 5 centimeters in a season.

The neighboring parc, which is separated from the first only by a narrow tongue of land, can scarcely nourish the individuals confided to it. These anomalies are to be explained by the greater or less amount of food afforded directly by the soil, and by the percolations of fresh water, which are quite abundant in the parc in which the development of the mollusk is so pronounced.

During 1875 the MM. Charles sold 5,500,000 oysters, of which 2,500,000 were ready for the table.

The spawn raised here is brought from Auray, and I will add that it produces, in the plantations of Lorient, individuals distinguished alike for the delicacy of their flavor and the fineness and lightness of their shells. I have seen many of them that were in no respect inferior to oysters of Ostende.

AURAY AND LA TRINITÉ.—Auray and La Trinité are, with Archacon, the most important oyster centers of our coast. They are more particularly engaged in propagation.

The oyster deposits of the river Auray are fully three leagues in length. They extend from the mill of Poulben and the chapel of Saint-Avoye to the canal leading into the salt marshes of Coat-Courzo, and form an unbroken series of beds covering an area of more than three hundred hectares.

In the river of La Trinité, near by, which is also called the Crach River, are also found numerous beds of oysters, but the accumulations here are not so extensive.

The beginnings of oyster-culture in this part of the Morbihan date back a dozen years. The development which has taken place in this time is not to be attributed to private enterprise alone. The part played by the administration has been considerable. The legislative restrictions enacted encountered at first much opposition among the fishermen, for their principal object was naturally the preservation of the beds which were being pillaged without restraint and without discretion.

What would have become of the oyster industry at Auray and La Trinité if these beds, which to-day make the fortune of the parqueurs, had disappeared?

As has been so judiciously stated by M. Platel, who has published a most complete and accurate account of oyster-culture in the Morbihan, from which I have derived most valuable suggestions, we cannot too often recall how necessary was the perseverance and the solicitude of the maritime administration of Lorient, Vannes, and Auray, in order to preserve the foundations of this wealth scattered in the rivers of the Morbihan.

My report upon Auray would certainly be incomplete if it did not bear testimony to the zeal of M. Coste, the Commissioner of Maritime Inscription, whose praise is in every mouth. This distinguished functionary, prompted by the spirit of his official instructions, has everywhere lavished encouragement and advice.

It would be impracticable for me in this brief narrative to review all the establishments of the River Auray. I will take as a model the establishment of M. de Thévenard, one of the most complete and the best organized as regards reproduction, and which I have perhaps studied more carefully than the others.

ESTABLISHMENT OF M. DE THÉVENARD.—The site of the establishment of M. de Thévenard, the mayor of Auray, is at a place called Le Rocher. The concession comprises parcs for reproduction and claires for the growing and sheltering of the oyster. The parcs are established, some upon bottoms where the mud is three or four meters in depth, and the others upon firmer soil.

Buildings erected upon the banks of the river serve as workrooms where the processes of separating and assorting the oysters and coating the tiles with whitewash is carried on, and also as storehouses for the nursing frames.

In front of the buildings, and at a distance of a few meters from the shore at low water, water-tight pits have been excavated in which are placed during winter the fry bred the previous season, to protect them from the cold.

The collectors made use of by M. de Thévenard vary with the nature of the soil. Upon miry bottoms they are formed of a bunch of ten tiles superimposed two and two, successive rows alternating in direction, and are suspended to a stake two meters high.

A plank nailed to the stake about 30 centimeters below the tiles prevents the apparatus from sinking into the mud. This very ingenious system, which permits the collectors to be established upon the miry bottoms of all the rivers of the Morbihan, was invented by M. Eugene Leroux. M. de Thévenard perfected it, by adding a second plank above the first.

Where the foundations are firmer they use the common straw collectors (*ruches*), or simply content themselves with placing tiles one above the other on wooden frames. Sometimes also they use collectors made of boards.

Before immersing the collectors they are covered with a coating of mud, to which hydraulic lime is added to give it cohesion. The method pursued by M. Martin of the River Crach, which has been adopted by M. de Thévenard, is as follows:

Into a large vat filled with salt water is stirred mud, to which is added one-tenth its volume of hydraulic lime. It is necessary that the mixture be thin enough to spread easily, then the collectors are immersed in the bath, and remain three or four hours; afterwards and before the coating is entirely dry they are immersed in another vessel containing only hydraulic lime in suspension in sea-water.

The collectors are put in place early in the month of June, when the emission of the spawn begins. The spawning season is prolonged to the month of August, or even later in the river Bono. They are withdrawn at the beginning of winter in order to detach the young oysters.

M. de Thévenard effects the removal of the collectors by means of a barge upon which is erected a lever or sweep, to one of the extremities of which is attached a cord and hook. This is fastened to the collector, which by means of it is readily lifted from the water. This method saves a great deal of time, for the collectors can be readily and easily lifted at all stages of the water. The removal of the young oysters from the board collectors is effected in November and December, and from the tiles in the month of March following. The oysters detached before winter are collected in nursing-frames, and when no further danger is apprehended from the cold these frames are lowered into the river, where their growth is more rapid.

ESTABLISHMENT OF THE BRÉNÉGUY.—Not far from the river Auray, behind Locmariquer, a very interesting establishment has been created by the society of which M. d'Argy is superintendent. This

establishment occupies an area of forty-five hectares in the haven of the Brénéguy.

Lying in an indentation of the shore, and separated from the sea on the west by a natural embankment not subject to overflow, it communicates with the ocean through the bay (*anse*) of Kerlud. Another embankment, 145 meters long, built of earth and masonry, and provided with two sluice-gates, closes in the basin on this side, protects it from the storms, and maintains the level of the Brénéguy at high-water mark. This vast pond contains 900,000 cubic meters of water, and its depth varies from one to three meters.

The sluice gates are only opened during the spring tides, consequently the waters are renewed but twice in a month. The winds, which blow without ceasing upon the coast of Morbihan, effect the aëration of the water and prevent it from becoming impure. The soil is granitic. In some parts a thin layer of mud covers the bottom.

It is hardly necessary to state that the oysters grown in this establishment, commenced only two years ago, are obtained either at Auray or La Trinité. The fry are placed in metal trays supported in frames of wood, and the larger individuals, which are not liable to be destroyed by the crabs, are spread over the bottom. The oyster grows very rapidly in the basin of the Brénéguy, acquiring qualities like those which characterize the products of Bélon.

As at Bélon, also, the dredged oysters, when cultivated, quickly change their form and assume better proportions.

M. d'Argy proposes to perfect his establishment, already so complete in its details, by attempts at reproduction upon a grand scale. My conviction is that this establishment, which at the present time is prepared to deliver several million oysters to consumption, is destined to great development in the future.

Among the different establishments upon the river La Trinité, I would direct special attention to that of Doctor Gressy, to whom we owe various improvements introduced in the methods of cultivation.

The island of Cuhan, upon which the establishment is situated, contains basins excavated in the solid rock, and in which, in consequence of their elevation, the water is renewed only twice in seven days. In these basins M. Gressy has experimented with the object of effecting the greening of the oyster. The end desired has been obtained, but in transportation the oysters lose to some extent the color which is characteristic of the oysters of Marennes.

The methods pursued in the cultivation of the oyster are very nearly the same at La Trinité as at Auray. Nevertheless, some cultivators upon the river Crach find it preferable to detach the young oysters from the collectors at the beginning of winter. They give as a reason for this premature detaching, that the fry grow much more rapidly in La Trinité, and the shells are at this period strong enough to bear the operation without injury.

Some of the cultivators of this locality have a peculiar system of *détroquage*. Instead of detaching the young oysters from the tiles, these are broken into fragments, one oyster being left adhering to each fragment.

The object of this method is to enable the cultivators to dispense with the nursing-frames. Its advantages are as follows:

1st. The young oyster, protected by its firm adhesion to the fragment of tile, cannot easily become a prey to its enemies.

2d. The fragment of tile adhering to the shell increases its weight and prevents its being shifted by the currents when placed in situations to which the currents have access.

I would also refer to the very fine submersible ponds of the MM. Leroux, constructed in the open river, where the oysters are kept until fully grown; also, to those of M. Martin, and the grand establishment of M. le Baron de Wolbock, nor must I forget the parcs of the Sea-fishermen's Association of La Trinité.

In 1869 the administration of the marine, with the view of promoting the development of practical oyster-culture, which has for its object the collection of spawn, distributed 150,000 tiles as well to this association as to individuals holding concessions from the marine which they cultivated on their own account. The association has prospered, and by reason of its success, which continues to increase, it has greatly augmented its commercial importance.

The river Saint-Philibert, between Auray and Crach, the river of Vannes, of which I shall shortly have something to say, and Morbihan Bay (*la mer intérieure du Morbihan*) are localities suitable for the breeding and the cultivation of the oyster. It will be sufficient to mention the establishments of the society of Sainte-Anne, those of MM. Eden and Fardin, at Peningtoul, those of M. Pozzi, and those of M. Leclair, which are in full operation.

What is the actual condition of oyster-culture in the district of Auray? I may affirm without fear of contradiction that it is prosperous. The one thing needed is an outlet for its products. The oyster-cultural stations of Normandy and the few establishments of Brittany, which are devoted to the cultivation of the oyster, are not sufficient to give room for the hundreds of millions of young oysters which are collected each year in those wonderfully productive rivers, Auray and La Trinité. The collection of fry in 1876 will be still more considerable than for the preceding years. At first they were well satisfied when they succeeded in fixing 20 or 25 spat upon a tile. Now the number averages from 250 to 300. Some tiles are found upon which there are more than 1,000 individuals.

The following statistics, which I owe to the courtesy of M. the Commissary of Auray, will furnish the information necessary to complete this part of my report:

The total number of oyster-cultural establishments for which land

has been granted and which are in operation is 297, classed as follows: parcs, 277; claires, 20.

During the season of 1875–'76 were introduced into the parcs 4,401,400 oysters, obtained by dredging; their approximate value was 118,425 fr. 18 cent. [$23,685]. During the same period there were sent out from these parcs 7,538,150 oysters, having a value of 202,801 fr. 60 cent. [$40,560]. The difference between the number received and sent out is accounted for by the fry raised by the planters themselves.

The number of fry sold during the same period, either to establishments in the vicinity or at a distance, was 26,176,300, representing a value of 102,385 fr. 95 cent. [$20,477]. All of these were collected upon tiles.

In 1874, from the collecting tiles, numbering 2,580,370, there were obtained 110,563,750 fry, after deducting losses from handling. Of this number Auray is to be credited with 66,195,900. There still remained in the parcs on January 1, 1876, 97,348,950 fry, of which more than 60,000,000 were in the establishments of Auray. These statistics are derived from the holders of the state lands granted for oyster-cultural purposes, whose figures are generally too low, and we may safely estimate the number of fry still to be disposed of at 120,000,000.

Without counting the associations of fishermen, who work themselves and are at little or no expense for hired labor, the number of days' labor performed in the parcs during last season was as follows: By men, 35,819 days; by women, 51,709 days; by children, 2,150 days; in all, 89,678 days.

The result of this labor has been that the natural oyster-beds, being well cared for and protected, and worked with moderation, have become more and more fertile; and the fishing of these beds, which there seemed to be reason to fear would disappear forever, has, on the contrary, become more productive.

We may add that, in those households which are willing to work, comfort has succeeded to want, and we should not forget that the Auray district (*quartier d'Auray*) is but just beginning its development.

VANNES.—Before the collection of spawn became in the Auray district a considerable branch of industry, the oyster-culturists on the river Vannes and in the gulf of Morbihan gave their attention solely to the cultivation in parcs of the oysters obtained by dredging from the once fertile beds of this bay. It had, however, some years ago, occurred to M. Chaumel to make some attempts at propagation, but they were without results.

The beds of Morbihan were exhausted many years ago, and the drag-net fishing (*la pêche au chalut*), pursued without intermission, prevented the fixing and growth of the few embryos that the few remaining oysters still produced. The administration of the marine realized that these oyster beds, which had been unproductive for fifteen years at

least, could only be rescued from total destruction by close supervision and restriction of the drag-net fishing (*pêche au chalut*). Measures were taken with this view, and the restoration of the beds was attempted. To accomplish this one hundred and thirty thousand parent oysters, having a large number of young ones attached to their shells, were transported from the beds of Auray to the inland sea of Morbihan [Morbihan Bay], and distributed over the site of the old beds. This was followed with the best results, the attempt being crowned with complete success, especially upon the bed of Bernon. To-day, the condition is much improved; spawn has appeared at various points, and we may reasonably expect that in less than ten years, perhaps, the gulf of Morbihan will have recovered its former productiveness.

I will now invite attention to the condition of oyster-culture in the maritime quarter of Vannes. There is progress—progress that cannot be disputed. In 1874 land had been granted by the state for 140 parcs, and the number has since risen to 356. Two branches of the oyster-cultural industry are practiced at Vannes, propagation and rearing. The work of propagation has not attained important proportions. The cultivation of the oyster, on the other hand, has been carried on with encouraging results.

The immense tracts in the gulf of Morbihan, which are left bare at low tide, offer most favorable conditions for cultivation. It is true that the sea is often turbulent, but the numerous currents which traverse it in every direction prove but another element of success when durable parcs have been once established.

Three hundred thousand tiles, intended to catch and fix the spawn, have this year been placed at different points in the river Vannes. The number of spat adhering to each is estimated at from 30 to 60, depending upon the location.

Among the establishments which have been founded in the neighborhood of Vannes I may mention that of MM. du Chélas & Co., situated upon the island of Bailleron, and having attached to it two parcs, one on the isle of Lerne and the other on the isle of Illure; and those of MM. Chaumel, Vincent and Liazard, de Lamazelle, and Paul.

As an experiment five thousand tiles were immersed by the MM. du Chélas & Co. in the vicinity of the beds of Bernon and Bailleron in 1876.

ESTABLISHMENT OF M. POZZI.—The establishment of Ludré, which M. Pozzi organized, with the assistance of M. Dalido, in 1874, may be regarded as one of the best arranged in Brittany. It is situated near Sarzeau in the Gulf of Morbihan. It embraces—

1st. Storage parcs, having an area of 5 hectares. These were formerly salt marshes which have been adapted to the purpose for which they are now used.

2d. A feeding reservoir (*Une reservoir de décharge.*)

3d. Two submersible basins. It also has connected with it parcs, situated upon the islands of Kistinic and Lerne, for the growing of the oyster and its preparation for transportation.

The basins designed for the winter quarters of the oysters are fed upon one side by a vast pond having an area of 40 hectares and receiving water at each tide, except during the neap-tides. Upon the other side is a sluice-gate which permits the entrance of the rising tide and through which the water is drawn out when it is desired to empty the basins. The bottom is composed of mud and sand and is for the most part firm.

The system of cultivation which has served as the basis of the labors of M. Pozzi is the system of continuous currents. In carrying out this plan M. Pozzi has simulated the conditions under which the natural beds of oysters are placed and has had every reason to be satisfied with the method. During the first year, 1875, the results were marvelous. The present year they have surpassed all expectations. By means of the pond of forty hectares and the sluice-gate on the opposite side he was able to maintain a constant circulation of water in the parcs.

A portion of one of the storage basins, that one in which the oysters are spread over the bottom to thicken up (*epaissir*) during the winter, is asphalted. Such an exclusive appropriation would hardly be profitable in an establishment less extensive than this. In this case it has been rendered necessary by the presence upon the bottom of these transformed salt marshes of decomposing vegetable matters.

This parc has an area of 2 hectares. It is divided into five parallel compartments, having each a length of 200 meters and a breadth of 15 meters. Each is in direct communication with the feeding pond, by an independent water conduit. This subdivision was adopted by M. Pozzi with the view of securing a rapid current through all the compartments. Without this precaution—had the water been introduced into the pond through a single channel, the force of the current would have been lost in the vast extent of the two hectares of surface, and neither the oysters upon the sides nor upon the bottom would have profited by its beneficent influence. As may be seen, the practice of M. Pozzi has been consistent with the principles upon which he has founded his operations.

In the arrangement of the submersible basins he has carried out the same ideas.

These basins are excavated in rock, and surrounded with walls of stone, laid in cement, which have a thickness of 60 or 80 centimeters, and rise to a height of 80 centimeters above the surface of the ground. They are situated at the extremity of a small peninsula, in close proximity to the workshops. The two basins are nearly equal in size, and have an aggregate area of 50 meters by 28 or 29 meters. They receive water at every tide. Each compartment contains 200 frames, aligned in the direction of the current, and separated by intervals of 50 centimeters. Each frame is numbered, in order that a record may be kept of the fry obtained from different sources, and its progress noted. The frames are ballasted by heavy stones to keep them in position.

The interior of each frame is divided into five or six compartments.

by means of wooden cross-pieces, in order that the young oysters may not be displaced by the action of the sea. Under the influence of these currents, the fry undergo extraordinary development. For example, I have seen young oysters removed from the collectors the present season which in the space of three months had increased in dimensions from 4 to 4½ centimeters.

The "sulky" oysters, which have been obtained by dredging or raised artificially, are not slow under this treatment to take on vigorous growth. During the present season M. Pozzi placed 70,000 of these sulky oysters in the tail-race of his mill, and by regulating the flow of water subjected them to the action of a swift-flowing current. In forty days these oysters, which had a mean diameter of 3 centimeters, had attained the dimensions of 6 or 7 centimeters.

The submersible basins, the parc at Kistinic, and those upon the Isle of Lerne, are appropriated to the cultivation of oysters in frames. However, those portions of these last parcs, where the current is sluggish, are reserved for bedding (*étandage*); oysters which have already attained a diameter of 4 or 5 centimeters being subjected to this treatment. The increase in dimensions of individuals bedded upon the bottom is not more than 2 centimeters, but the shell becomes broader and deeper and of better shape, and the animal, without being fat, completely fills the interior. The fattening of the oysters is not the end sought by M. Pozzi; he has rather aimed to put to profit the exceptional advantages which his field of exploitation offers for the growing of the oyster.

The following are the operations of M. Pozzi, and they comprise what in Brittany is technically termed oyster breeding or rearing. For example, the young oysters (*naissain*) purchased by M. Pozzi in March, 1876, were spawned at Auray in August of the previous year. In March, 1876, they were removed from the collectors (*détroqué*). In April they were transferred to the Isle of Kistinic, and at once placed in frames. After two months a part were sent to the principal establishment at Ludré and placed in the submersible basins.

The sale of these young oysters took place in the month of September of the same year, at which time they had obtained a diameter of from 4 to 6 centimeters. If the purchaser cannot remove them at once, or if all the stock is not sold, the young oysters are transferred to the storage parcs, where they pass the winter.

The oysters are usually purchased by merchants from the Isle of Oléron, Marennes, and La Tremblade.

The extensive parcs of M. Pozzi permit an annual production of 6,000,000 or 7,000,000 oysters. This number will be doubled when the work of converting the salt marshes into parcs, which has been undertaken at Ludré, shall be completed.

LES SABLES D'OLONNE.—It is only in the last three or four years that oyster-culture has been held in esteem at Les Sables d'Olonne.

Prior to this there existed only *dépôts* or holes in which the merchants deposited the oysters they had purchased at Noir-Moutiers until a favorable opportunity occurred to sell them. It is due to the example set by the administration of the marine that the parqueurs have at length determined to put under cultivation the productive submersible areas of the haven of Les Chasses and convert them into parcs.

The haven of Les Chasses has an area of 64 hectares. Of this only 25 hectares are suitable for the cultivation of the oyster. It is overflowed by the tides only once a week, but for two or three consecutive days. The bottom consists of sand mixed with mud and clay.

The water which enters the inclosures (*claires*) is thickly loaded with the earthy matters taken up in the harbor. This necessitates the frequent cleaning of the parcs, in which it is absolutely necessary to prevent any accumulation of ooze or sediment.

These parcs, or "claires," as they are termed at Les Sables, have an average superficies of 250 square meters. The area varies according as the inclosures are more or less sheltered from the winds. The water is retained in the parcs by earthen embankments. These are of such height that when the tides run, out only such a depth of water is retained as is necessary to protect the young oysters from too great heat. It is not necessary at Les Sables d'Olonne to observe any precautions against cold.

I am assured by the parqueurs that the shallower the claires are, and consequently the more the oysters are subjected to the influence of heat and light, the better they do.

The rearing and fattening are the familiar phases of oyster-culture to the planters of Les Sables. Their methods are based on theories directly opposed to those of M. Pozzi at Ludré. At Les Sables, in fact, there are no currents, and the waters are very slowly renewed only once in eight days. Last year, by reason of some constructions undertaken in the harbor, the water remained unchanged in the claires for an entire month, with no injurious results to the oysters. Truly, one is astounded at the rapid and really surprising growth of the mollusk under such conditions. In a single spring tide the increasing diameter amounts sometimes to a centimeter. Sometimes in the course of forty-eight hours a young oyster, injured in the process of detaching from the collectors, will reconstruct its shell so strongly as to afford secure protection from its enemies. The young oysters (*naissain*) are brought from Auray. They are transported in boxes enveloped in damp seaweed. Some planters have them transferred without being detached from the tiles, place them aside, and do not effect the removal from the collectors until a later period. At first they are placed in nursing frames, where they remain from fifteen to thirty days in order that the injured ones may have time to heal; then they are scattered over the bottom of the claires. In two years at most the young oysters are fit for the table.

The following measurements, showing the increase in the dimensions of oysters reared by M. Mounier, will prove of interest:

An oyster, said to represent a fair average, which was spawned at Auray in 1875, and was detached from the collector in January, 1876, had a diameter when placed in the parc, the following April, of 2½ or 3 centimeters. Early in September of the present year its diameter had increased to 7 centimeters 8 millimeters. Another, spawned in 1874, and placed in the parc in April, 1875, measured, about the 1st of September, 1876, just 9½ centimeters. Finally, a specimen spawned in 1873 had acquired in September, 1876, the enormous diameter of 11 centimeters 4 millimeters.

Like results have been obtained at the establishment of Dr. Leroux. In the month of March of the present year M. Leroux transferred from his parcs at La Trinité some of the fry of 1875, which had been detached from the collectors in January, 1876. At the period of my visit to Les Sables, these oysters had attained diameters of 7 and 7½ centimeters.

The method of treating the oyster is the same at Les Sables as elsewhere. The manipulations are neither more nor less frequent. Care is taken that they shall not become covered with mud. The parcs are carefully maintained in repair. The confervoid growth is removed as it forms. Placing too great a number of oysters in one inclosure is carefully guarded against.* In the intervals between the necessary manipulations the parcs are left undisturbed.

Although the concessions at Les Sables d'Olonne are of very limited extent, they raise there each year about 10,000,000 oysters, hardly one-tenth of which are obtained from the dredging. It is not to be presumed that this is the limit of production.

The conversion of the salt marshes adjacent to the oyster parcs into claires will be accomplished in a very short time.

Isle de Ré.—In the Isle de Ré the breeding and rearing of oysters is carried on to some extent, but this industry is not very important. The areas suitable for the cultivation of the oyster are not extensive, and moreover it is not possible to utilize the western shore of the island on account of the violence of the sea, which is there called "*mer sauvage*."

Among the parcs which are maintained, I will mention those of M. Dupeux-Boyer. They were established about fifteen years ago in the premises of an old mill. The are situated at Martray, in the face of the sea ("*mer sauvage*"), but protected from its violence on one side by a sand-dune, on the other by the Bay of Bier-d'Ars, the waters of which are conducted to them by a canal.

The concession is divided into claires averaging 50 to 60 meters in length and 20 to 30 meters in width, which are separated by earthen embankments from 25 to 30 centimeters high. These claires receive water at every tide.

* A claire having an area of 150 square meters, for example, should not contain more than 6,000 to 8,000 oysters.

M. Depeux-Boyer, an experienced oyster-culturist, has observed in common with the parqueurs of Les Sables d'Oléron, that the less water there is in the parcs the better the oysters seem to do.

The bottom is a clayey loam, the surface of which is covered by a layer of mud from 20 to 30 centimeters in thickness, but of sufficient firmness to prevent the shells from sinking in it. The claires of Marttray, which are cleaned only once or twice a year, are appropriated to the rearing and fattening of the oyster.

The oysters handled there are either brought from Arcachon or are obtained from the parcs of reproduction which M. Dupeux-Boyer possesses in another part of the island, at the place called La Moulinatte, or in many cases they are collected along the shore, by the foot-fishermen (*pêcheurs-à-pied*). Although for many years the oyster beds of the vicinity have been exhausted, there still exist isolated oysters, the spawn of which catches either upon the rocks or the pebbles that the waves roll upon the beach. The oystermen call them native or vagabond oysters. The shell is coarse, but regular and deep.

In the parcs of reproduction, where it would be impossible, on account of the violence of the sea, to employ the usual forms of collectors, the spawn is allowed to catch upon the shingle of the beach. The detaching of the young oysters is consequently an operation of some difficulty.

Two or three years are necessary to prepare the oysters brought from Arcachon for the market, in the claires of Martray. The native oysters are less liable to mortality; they grow more in the same period of time; the shell becomes deeper and the animal larger.

The parcs of Martray, like those at Marennes, have the property of greening the oyster. Some individuals, however, in the claires of the Isle de Ré, never assume the green coloration, which in most cases manifests itself about the time of the September equinox.

ISLE D'OLÉRON.—Oléron, which may be regarded as an appendage of Marennes, engages in the rearing and fattening of the oyster and in its reproduction. In 1873 the season was bad; the spawn did not catch upon the collectors, and the discouraged planters (*éleveurs*=breeders) abandoned their parcs.

The administration of the marine intervened to prevent total ruin. It established model parcs and brought from Arcachon 250,000 breeding oysters and placed them in "*la Courant*." It endeavored by every means to restore the courage of the parqueurs, who had given way to unwarranted apprehensions. The counsel of the administration of the marine was heeded. The parcs, which had been invaded by mud and the mussels, were soon restored to good condition. Since then the cultivation of the oyster has succeeded so well that no one thinks now of abandoning oyster-culture.

In 1875 the parqueurs of Arcachon established themselves in the island of Oléron, and the quantity of oysters they brought with them was so large that the collectors were covered with spat. The same

season there was an abundant setting of spat in the experimental parc established by the administration of the marine. Oysters and collectors were also placed in "*la Courant*," to form the basis of a natural bed, to serve as a center of reproduction.

There are at Le Chateau, the point where the work is principally carried on, 2,000 parcs; at Saint-Trojan, 700; at Dolus, 300; in all, 270 hectares are under exploitation. These localities are situated opposite the mouth of the Seudre. At Le Chateau the parcs begin at 1 kilometer from the line of high water and extend back a distance of 4 kilometers.

The present year 300,000 tiles have been placed out. These collectors have not been covered, as usual, with sand and cement, as the coating would not be permanent in consequence of the storms and intense cold to which this coast is subjected.

The cultch (*naissain*) from Brittany, which is reared on the island, usually does better than that of Arcachon. According to the cultivators, the oysters which are brought from the north have a tendency to grow more rapidly in the south. While this probably is due to the effects of climatic influence, we know that the rule is by no means absolute; for example, the oysters of Portugal, although native to a country much warmer than ours, far from dwarfing in our waters, acquire there an enormous size.

The younger the oysters are when they arrive at Oléron the more rapid is their development. Nevertheless, some of the parqueurs assert that the oysters obtained by dredging grow more rapidly than those gotten from the collectors. The reason given by them is that this oyster, accustomed to live at the bottom of the water, is more sensitive to the action of light and heat, which stimulates in them an energetic circulation.

The mussels are the most fatal scourge of the parcs of Oléron. They multiply in so great a number that if the parqueurs neglect to visit the inclosures each time that the tide permits them, these mollusks soon cover the bottoms to a thickness of from 20 to 40 centimeters.

I will here mention briefly the efforts of M. Gaboriaud, who has happily transformed some of the salt marshes into rearing-ponds (*claires d' élevage*). His experiments are, however, very recent, and need confirmation.

In order to give an idea of the unexpected development which the oyster-cultural industry has taken in the case of Oléron, I will say that the parcs of the present year contain more than 70,000,000 oysters fit for the table. As to the number of young oysters which have not yet attained the prescribed size, and fry still attached to the collectors, it is not possible to form even an estimate.

MARENNES.—The oysters of Marennes have a universal reputation. They owe their popularity to the peculiar taste contracted in the greening claires. There is no point along the whole coast where the green-

ing of the oyster takes place so readily and so rapidly as here. There are divers opinions as to what causes we must attribute the change which occurs in the color of the mollusk in the month of September. Some think that it is due entirely to the clayey soil of Marennes, to the brackish waters of the Seudre, or to oxide of iron. Others are as well assured that it is to be attributed to a sort of vegetation which covers the claires at the approach of winter, and disappears in the springtime. According to them, the oyster owes its color to the absorption of the chlorophyll with which the waters of the claires are saturated. A fact of common observation is that the oyster takes on its green color when the claire becomes green, and loses it as soon as the claire is deprived of its vegetable growth.

Although Marennes is very near Oléron, the experiments in reproduction which have been attempted there have not given any satisfactory result. This is not, as certain of the cultivators (*éleveurs*) assert, because the captivity of the oyster impairs its generative faculties. The oyster, whether it be in claire or parc, emits its spawn in the spring. We must, therefore, believe that the spawn does not encounter in the water of Marennes, heavily laden with earthy matters, and perhaps too sluggish, the conditions necessary for its existence.

The areas under cultivation comprise *viviers*, *dépôts*, and *claires*. The *viviers* are small establishments, having an area of about 400 square meters, surrounded with walls of dry stone 20 centimeters in height, situated upon the strand, and submerged by the sea at each tide. The *dépôts* are established upon the muddy flats along the shore. They are inclosed by branches of tamarind stuck in the mud, which also serve the purpose of showing the lines of demarkation between different proprietors. The *claires* are basins, from 30 to 35 centimeters in depth, excavated along the banks of the Seudre.

The earth which has been excavated from the bottom of these serves to form a bank, the top of which is about one meter above the bottom of the reservoir. They are divided into deep and shallow claires. The shallow claires, placed nearer to the shores of the Seudre, receive the water more frequently. The deep claires, being further from the shore and excavated in a surface which is more elevated, receive fresh-water but four or five days each spring tide.

The greater number of the claires are surrounded with a ditch, which is independent of the supply canal, in which they throw the muddy deposits which the sea brings in.

As I have already said, the deepness of the claires varies from 30 to 35 centimeters, but in the autumn the depth of water maintained is only from 24 to 30 centimeters. When the cold weather approaches their depth is increased, for the frosts and the snow are very much to be feared, and if the reservoirs chance to become covered with ice it is immediately broken up.

The shallow claires become green first. This condition lasts from the

month of September to the month of February. The deep claires begin to become green in the month of November, and lose their color about the month of April.

The oysters which are bred at Marennes are either produced in the parcs of Oléron or they are brought from Bretagne and Arcachon. Arcachon especially disposes of the greater part of its products as soon as they are salable.

The young oysters, when received, are first spread out over the bottoms of the *viviers* or in the *dépôts*. In November, after remaining here from six to seven months, they have attained a diameter of from 7 to 9 centimeters. According to circumstances, from fifteen days to a month is sufficient time for subsequent exposure in the claires in order that they may attain those qualities which permit them to be marketed or sent *au couteau*, using the expression employed by the parqueurs of the Seudre.

Before being sent from the parcs it is necessary, however, that they should be subjected to a last preparation, with the object of accustoming them to bear transportation without injury. To accomplish this, they are transferred to a compartment, the bottom of which is asphalted or covered with sand, and into which is admitted the purest and freshest water. The oyster remains some days in this reservoir, until it disgorges; then it is washed and shipped.

Some of the riparian land-owners, among others MM. Blanchard, Jourdes, and Le Beau, have converted into oyster claires the salt marshes situated outside of the maritime domain. The success of this enterprise is of lively interest at Marennes. The areas at the disposal of the administration are all allotted, and nevertheless numerous applications are received every day.

We may assert without contradiction that the success of this transformation is assured.

The oyster-cultural industry at Marennes has made considerable progress since 1873. Large parqueurs have come there and organized establishments complete in every detail of arrangement and administration. That of M. de Faramond, of Lafayole, which is one of the most recent, deserves some words of description.

The site of his establishment is at the mouth of the Seudre, in the Bay of Sinche. This establishment, which is very intelligently arranged, is composed of twelve claires, each about 40 meters square, six on each side of an embankment 2 meters wide. Upon this embankment M. de Faramond, who wished to avail himself of the most recent improvements, has constructed an iron railroad, with service trucks, in order to accomplish the rapid and inexpensive transportation of his oysters from the vessels to the claires, and at a later period to the disgorging ponds (*degorgeoirs*), and from there to the packing houses, situated at one end of the concession. He finds it advantageous to keep in each claire oysters of all qualities and all dimensions. Consequently he has but a single compartment to enter to get whatever kind is in

request, and he avoids the great inconvenience of draining several ponds at times when it would be impossible to refill them. M. de Faramond has completed his packing establishments by an assorting machine, so ingeniously constructed as to permit two women to assort 30,000 or 40,000 oysters in a day.

In conclusion I present the following statistics:

In 1873, according to the register of maritime fisheries, the number of shell-fish establishments was 2,564; in two years it has risen to 13,526.

The claires occupy upon each side of the Seudre a strip 20 kilometers long and 1 kilometer broad. The area exploited, therefore, is 4,000 hectares.

The number of oysters estimated to be contained in these concessions is 80,000,000.

In fine, we may say that oyster-culture makes the fortune of the majority of the inhabitants of this region. Almost all the families are proprietors or renters of a parc, a vivier, or a claire, which they cultivate themselves. Those of the working class who are not tenants or proprietors find occupation in the large establishments, and gain from two to four francs for two hours of work during the high tides. We may also add that the administration of the marine has addressed itself to the question of dividing in a more equitable manner those lands which are under its control.

LA TREMBLADE.—La Tremblade, situated upon the left bank of the Seudre, as regards the methods of production, cultivation, and greening pursued there, may be classed with Marennes. It has the same soil, the same processes, and the same systems of culture, with scarcely a shade of difference.

I would abstain from making any special mention of the oyster industry at this station if I had not collected some supplementary observations to those made at Marennes, which I will briefly sum up.

There are, as at Marennes, viviers and claires. The viviers are at the mouth of the river, and are exposed only at the season of high tides. In these the cultch is placed in order to grow.

The claires, situated at a higher level, in the case of a large number of the cultivators, who do not possess viviers, serve at the same time for the growth, the fattening, and the greening of the oyster.

La Tremblade grows largely the spawn of Bretagne, which, placed in the parcs about the month of March or April, when they measure from 2 to 3 centimeters in diameter, soon become edible oysters.

The greening occurs in a very short time. When a claire is "in humor," two weeks are sufficient; but it is necessary to guard with great care against emptying the claire, for it would be necessary then to wait an equally long time before it would recover its green color.

Northwest winds retard the greening, whilst those from the southwest favor it. These last being warmer and more humid, the oyster opens more frequently.

The claires are of contracted dimensions; and it has been remarked, especially in the case of the deep claires, which are submerged only three or four days each spring tide, that the smaller these are the better the oyster greens.

It has also been noticed in the parcs where the influx of fresh water is sometimes too abundant, that the development undergoes arrest, and the animal emaciates and quickly dies; while, if this water be absolutely wanting, not only does the oyster cease to grow or fatten, but it does not green.

Le Mus-de-Loup is the locality most favorable to the greening. It is generally agreed that this is due to the presence of fresh water. The reed grasses, which cannot grow in salt water, flourish upon the banks of the claires.

The cultivators of La Tremblade do not hesitate to attribute the greening of the oysters as much to the influence of fresh water as to the nature of the soil.

Some collectors have been placed in the viviers, but there has been no fixation of spat except in the case of the Portugal oysters.

LE VERDON.—Oyster-culture here is still in its infancy. The first attempts date from 1874, and were made by MM. Péponnet and Tripota. They succeeded badly; but we must not therefore conclude that the oyster-cultural industry cannot prosper in the roads of Verdon. Recent experiments under better auspices are announced; and if they succeed in excluding the fresh waters and the mass of sand which the Gironde accumulates, and which are the sole causes of failure, Verdon will be, on the other hand, a station admirably situated for the oyster business. Eighty hectares at least along the strand are susceptible of being put under cultivation.

In the course of this report I have several times referred to the oysters of Portugal, proposing to revert to this matter when I had arrived at Verdon. I did not think it necessary to speak of them at greater length in previous references. The oyster of Portugal has made its appearance in the last two or three years in our markets. It has entered into public consumption, and replaced for persons of moderate means our French oyster, the price of which is too high.

These oysters were originally derived from an immense bed found at the mouth of the river Tagus. The shell is rough and distorted, but it is generally well filled. This mollusk, whilst susceptible of acquiring a large development in our waters,* resists better the vicissitudes of weather, bears tranportation better, becomes acclimated in localities where our indigenous oyster could not prosper or live, and accommodates itself to all sorts of water. We are assured that its fecundity exceeds that of our native oysters. Its spawn, endowed with a strong vitality, can resist injurious influences for a long time, and be transported

* I have seen at Arcachon a Portuguese oyster which, after five or six years of sojourn in a parc, measured 28 centimeters from one extremity to the other of its shell.

to considerable distances by the currents without losing its vitality. Often the spawn of these foreign oysters is transported from the Gironde to La Rochelle, where, having attached itself to any hard body with which it comes in contact, it grows, fattens, and reproduces. It originates from the natural bed, which is formed not far from the Verdon, upon the old bed of Richard or Goulée, 9 miles from the mouth of the Gironde.

Only five or six years ago a vessel loaded with Portuguese oysters, in danger of sinking, discharged its cargo in order to repair damages. A part of the oysters supposed to be dead were thrown over into the river. Since that time these oysters have multiplied to such an extent, and the bed has become so extensive, that they dredge it without intermission during the season when fishing is permitted, without exhausting it or impairing its fertility. In fact, this oyster bed is a veritable fortune for the fishermen of the region, who gather each year from it an abundant and certain harvest.

ARCACHON.—Among the most important oyster stations along the whole coast of France, Arcachon is without a rival anywhere in the number of oyster beds exploited, the value of the oyster-cultural establishments, and the extent of business to which this industry gives rise.

The immense extent of salt water which bears the name of the Bassin d'Arcachon is excavated in the midst of a sandy plain, and is in permanent communication with the Atlantic only by a narrow channel opening. This little inland sea, into which many rivulets pour their fresh waters, so valuable an auxiliary in the cultivation of the oyster, is subjected to the same fluctuations of level as the ocean. It is traversed by currents which cross it in all directions and keep up a continual agitation. These currents circulate in channels of variable length, and of a depth which sometimes reaches from 40 to 50 meters. Between these channels are flats, known by the name of "*crassats*," which are laid bare at each tide. Upon these flats, thickly covered with parcs and claires, are established the most extensive oyster-cultural industries that are in existence.

The oyster industry at Arcachon was not created "out of whole cloth." It was called into existence by the presence of natural beds, to the number of nineteen, scattered through different parts of the bay. These beds, after having, like the oyster beds of the channel, and from the same causes, passed through a period of decay, which at one time excited an apprehension of their utter destruction, have revived, and are to-day of enormous fertility. The quantity of spawn which escapes, mingling with the embryos furnished by the oysters preserved in the parcs, is so very considerable that the mass of the waters of the bay are filled with it from the month of June to the month of August. The collectors are loaded with spat; and, upon tiles suitably placed, 1,000 or 1,500 individuals may sometimes be counted. If the whole generation that each year sees born attained adult condition, the Bassin d'Arcachon would be soon insufficient to contain so prolific a population.

Although these natural deposits are considered as centers of reproduction, and as such are under the strict control and supervision of the administration of the marine, yet every year for a few hours the dredging of them is authorized in order to remove the excess of production. In this short space of time vast quantities of oysters are collected and sent to market or laid down in the parcs. The oyster from this locality, called also native oyster, or "*gravette*," is very much sought for. It is distinguished by its peculiar form and its light thin shell from the channel oyster, which is less agreeable to the eye, and has much greater thickness of shell, and less delicacy of taste.

Arcachon possesses over all other oyster-cultural centers this advantage: that the mollusk receives his whole education there. He is born there, grows there, and from there passes directly into the hands of the dealer.

The study of the Bassin d'Arcachon would require long labor in order to be complete. It would be difficult for me in this summary report to pass in review all the industrial establishments there located. The number of them is too great, and their description would exceed the limit that you have permitted to me, Monsieur the Minister, and it would be fatiguing by its monotony, for in most of the concessions of the same group there is very little departure from the established methods and processes of the station. To carry out your wishes I have studied more in detail some of the establishments which have appeared to me to present most of interest, and which give an exact idea of oyster-culture as practiced at Arcachon.

ESTABLISHMENT OF THE OYSTER-CULTURAL UNION.—The Oyster-Cultural Association, at the head of which is placed M. Venot, has under cultivation an area of 42 hectares in the Bassin d'Arcachon, comprising, upon the one hand, the concessions granted by the administration of the marine to the Central Society for the Assistance of the Shipwrecked, and, upon the other, some lands situated near the light-house and the parcs of the Jacquets.

Le Cès is a place of natural reproduction. It consists of 11 hectares of land exposed at low tide and covered with herbage like a meadow. The soil, although sufficiently firm, necessitates, nevertheless, the employment of large "*patins*," the use of which prevents either the breaking or the burying of the shells in passing over them. They term the oysters which are obtained native oysters, or "*gravettes*."

This peculiar phase of the oyster-fishing is practiced by squads of ten women arranged in single file. Two file leaders, placed at the ends of the line, direct the march. The women, separated from each other by an interval of one meter, are each provided with four pouches attached to their belts, in which they place the oysters as they gather them. Those who follow detach these pouches when they are filled and empty them into baskets. The shells which are concealed from sight are collected by the assistance of a small rake, which is drawn over the ground in the direction in which the grass lies.

The fishing terminated, they stake out the square space over which it has taken place, in the first place in order not to expose it to being fished a second time, and in the second place to be able at a later period to cover it with shells of cockles and oysters, which are the natural collectors employed by them in order to maintain in these localities continued fertility.

The duration of the fishing in certain portions of these *crassats* does not exceed two hours or two hours and a half each spring tide; but as they employ 40 or 50 persons for this work the result is about 60,000 oysters for the day.

When the tide has driven off the workmen, each squad, by means of the *tillole* with which it is provided, goes to the ship Le Travailleur, which is the headquarters of the exploitation. The collections of the day are poured upon long tables, and the women proceed then to the singling and sorting of the oysters. They have such skill at this work and their eye is so well trained that they rarely have occasion to make use of measures in order to classify the shells by their difference in size. This operation completed the oysters are sent to the different parcs, to Lahillon in order to grow, to Crastorbe in order to fatten and to be put in condition for market.

LAHILLON.—The parcs of Lahillon are ancient oyster beds, from which they removed the grass in order to transform them into propagating claires (*claires de pousse*). Amid the marine grasses the growth of the oyster is less rapid than on the bare soil. A square space has, however, been left in its natural condition, and such is the quality of the ground of Lahillon that the oyster grows more quickly there than in the beds of Le Cès. The mean diameter of oysters fifteen months old is from 2 to 4 centimeters.

The claires measure 45 meters in length by 6 in breadth and have a depth of 30 centimeters. They are separated from each other by embankments 1 to 2 meters wide, formed by clods of clay, such as is found in the Ile des Oiseaux, and sustained by tiles placed on end.

One hundred thousand oysters may be planted in each of these claires. The subjects which are handled here are small oysters culled from the *crassats*, which must attain a larger growth before being fattened, and the spat obtained from the tiles, which, however, is only introduced after having remained in the nursing frames till about the month of April, and after the very dangerous tides that occur about the time of the vernal equinox are over.

The native oysters, which have undergone arrest of development, are placed in claires reserved for the purpose. In a short while in their new home they recover their normal rate of growth and gain in six months an increase of from 2 to 4 centimeters in diameter.

As it is essential not to lose an inch of this valuable exploitable ground, the shores west of the crassat of Lahillon are used as open parcs, but, in order to facilitate access to the claires behind, spaces have been left at intervals of 20 meters, by which the boats may reach the water.

Ile des Oiseaux (Parcs of Crastorbe).—The Ile des Oiseaux is the largest of the *crassats* of the bay, and the planters regard it as the most favorable ground for the cultivation of the oyster. The Oyster-Cultural Society possesses there 11 hectares of claires. The bottom of these claires has been transformed before being brought into use. It originally consisted of mud several meters in thickness, and of so little consistency that one could scarcely pass over it even by using very large *patins*. A consolidation of it was effected in the following manner: At first there was spread over the space a layer of shell and sand, such as is common in the Bay of Arcachon. Upon this layer, the thickness of which varied according to the greater or less consistency of the mud, there was spread another layer of pebbles as large as nuts, the material being brought from the quarries of Gazinet, near Bordeaux. These parcs being exposed to strong currents, it was necessary to surround them with pickets. They are emptied by a gate, which also serves to retain the water at low tide, when they would otherwise be left bare. In order to avoid the damage that the rising tide might cause, the gate is left shut until the sea has already filled the claire half full by filtering through the sides.

This portion of the establishment of the Oyster-Cultural Society is devoted to the fattening of the oyster and its preparation for shipment.

No oysters are marketed from the Ile des Oiseaux which have not attained a diameter of 6 centimeters or more, and although they grow deep and round there, they increase in diameter only about 2 centimeters a year.

The oysters cultivated at Crastorbe are obtained either from the natural bottom or from the tile collectors. A few of them have spent a portion of their time at La Tremblade; but in general their early growth is effected at Lahillon. I will add that the borders of the parcs of Crastorbe have retained the condition of natural oyster grounds.

MM. Venot & Co. cultivate both the native oyster and that obtained from tiles. Reproduction upon collectors is common everywhere at Lahillon and in the parcs of the Jacquets. Tiles alone are employed and are placed in position sometime in May or June, according to the mean temperature of the spring, which, moreover, regulates the time of the emission of the spawn. They are removed about the month of November. The detaching of the shells from the tiles is performed upon [the vessel] Le Travailleur, generally before winter approaches. The young are placed in frames soon after, upon which they pass there the cold season and repair the damages that the *detroquage* has caused to the shell. When transferred in the spring to the parcs of Lahillon they have become sufficiently strong to defy their enemies.

The Oyster-Cultural Union the present year immersed 110,000 tiles, and its parcs contain about 30,000,000 of oysters. Sixty persons are

continually occupied in this vast exploitation, and the number is increased at busy periods to 80 or 90.

Experiments have been made by M. Venot upon American oysters. Of four lots of spawn forwarded from America two arrived in good condition, and the surviving individuals were placed in the parcs of Crastorbe, and promptly recovered from the fatigue of their long journey. Their development was rapid. We can best compare them with the oysters of Portugal, which these American specimens resemble in a great many respects. The American oyster has been little appreciated in our country. Its rearing has been abandoned.

As with almost all the principal oyster-culturists, and especially M. Montaugé, whose establishments are conducted on a grand scale, the oysters issuing from the parcs of the partnership of Venot & Co. are not immediately sent to market. They are first transported to basins convenient to the warehouses, where they are permitted to disgorge. Then they are washed and sorted again. The sorting is done by means of machines, which render this service easy. A single woman can sort in one day from 20,000 to 30,000.

THE ESTABLISHMENT OF SAINT JOSEPH.—Among the principal planters on the Gironde, who, in addition to the conduct of their business, have devoted themselves to experiments with a view of perfecting oyster-cultural methods, I may cite the brothers MM. de Montaugé, who have organized upon the road from La Teste an experimental laboratory in their great establishment of Saint-Joseph.

This laboratory, to which will be very shortly annexed a cabinet of research and observation provided with microscopes, consists of a basin having an area of 1,500 square meters and a depth of 1 meter, which is divided into two compartments, one of which is devoted to the preparation of the oysters which are to be shipped, the other to experimental work. The bottom of the first compartment is asphalted; the bottom of the second has been excavated, and the material removed replaced by a layer of clay rammed and puddled, surmounted with another layer of sand and shells. These arrangements have been made in order to prevent any infiltration of water derived from the springs which rise in the grounds of the MM. de Montaugé, the metallic ingredients of which are injurious to the oyster.

The basin is fed by means of a great sluice gate, which is opened by the rising tide and closed when the tide returns. This gate is placed at the head of a canal, the entrance to which is in the mouth of a small stream of fresh water. At the beginning they exercised the greatest care to prevent these fresh waters from mingling with the water of the sea during the renewal of the supply in the basin.

MM. de Montaugé studied in one of their experiments what aptitude the captive oyster had to produce spawn capable of developing. For three years the adult oysters placed in the reservoir of observation apparently did not emit any embryons. They even became emaciated. The ex-

perimenters attributed this waste to the too great saltness of the water, which had reached such a point that it deposited crystals of salt upon the marine plants contained in the basin. The failure was notorious. The experiments were abandoned, the oysters removed, and the area of water converted into a fish pond. From this time they neglected to prevent the mixing of the fresh waters of the brook, to which I have referred, with the sea-water in the canal. Some time afterward, in raking over the bottom, they found some forgotten oysters. They perceived that they had grown most surprisingly. There were found traces of spawn in the vicinity of the gate and of the springs which burst out here and there upon the edges.

This event, entirely accidental, was a revelation which put the MM. de Montaugé upon the way to the truth. Some hundred oysters were again deposited in the basin, and collecting apparatus arranged around them became loaded with spawn.

It has been denied that these embryons came from the specimens that were the subject of experiment. From what source, then, could they have come? No parc of reproduction existed in the neighborhood. The waves, which in such case must have served as the vehicle for their transportation, traversed several kilometers of *crassats* before penetrating this establishment, and on this long passage across tide-flats under the summer sun, the sea-water is so heated that spawn loses all vitality there. Again, they have objected that if these waters were too warm to present to embryons the normal conditions of existence, how could they serve to preserve the spawn of captive oysters. The explanation of this is not difficult to find if we remember that they permitted the fresh waters from the brook, already referred to, to flow into the canal of the establishment, and these by their coolness lowered the temperature of the salt water.

In a second experiment, the MM. de Montaugé, with the object of determining what was the influence of the heat of the sun upon the development of the oyster, placed in a portion of their basin earth extracted from the parcs of Oléron. Oysters of the same size and age were placed upon this earth and others by the side of them upon the ordinary soil of the bottom. The result was that the growth of all of them was very nearly equal; but the first were in better condition, were more wrinkled and more strongly ribbed.

All oyster-culturists know that very great cold and frost are to be esteemed among the most terrible enemies of the oyster. The proprietors of the establishment of Saint Joseph possess a basin containing 200,000 oysters. The basin having been frozen over, the MM. de Montaugé immediately caused the water to be renewed and the reservoir to be covered with straw and hay. This means succeeded, and only 100 of the oysters were affected by the freezing.

I may not leave the establishment of Saint-Joseph without noting an observation which is of peculiar interest. In the parcs much exposed

to the storms they turn the oysters over during the bad season and place them on their flat side. This ingenious arrangement renders the animal less susceptible to the action of the cold, gives a better bedding to the shell, and prevents it from being too easily shifted from its position by the inflow of the coming and the suction of the receding wave.

MM. Grangeneuve & Co. also possess an establishment which deserves special mention. M. Grangeneuve has solved the difficult problem of raising the oyster in nursing-frames from its birth up to the time when it is ready for the table, thereby reducing the very large expenses which are incident to the practice of this method. His establishment is a very fine one, and nothing has been neglected to make it one of the most complete at Arcachon.

The establishment of M. Grenier presents equally as much interest. M. Grenier is one of the oldest planters of the bay, and has rendered more than one service to the industry which he has pursued for so long a time.

MM. Brown and Goubie have introduced into their parcs an innovation by building the bottoms and sides of their claires of cement, which diminishes greatly the expense of maintenance necessitated in ordinary claires. These are costly to construct, are very strong, and are especially good in those localities where they are exposed to the violence of the sea.

M. Vidal, on the contrary, employs for the construction of his claires neither tiles, nor planks, nor cement. He has succeeded in establishing with mud and clay rammed and puddled embankments sufficiently consistent to resist the waves. It is true that the parcs of which M. Vidal is the proprietor in the Ile des Oiseaux are very much sheltered, and the application of this system, evidently economical, would not be possible for most of the concessions in the Bassin d'Arcachon.

Besides his parcs of production, M. Fillon controls a shipping-house very skillfully arranged, and in which he has made numerous and interesting experiments. M. Fillon is, moreover, one of those planters who conduct the oyster-cultural industry on a grand scale.

It remains for me yet to mention M. Surette and M. Gaston de Faramond, who give their unceasing efforts to the progress of oyster culture.

Before summing up with some statistical tables, I pause a moment to say that the products of Arcachon are not all as we see them commonly in our markets. Those minute oysters that the parqueur, impatient to realize on, sends to market as soon as they attain the prescribed dimensions of 5 centimeters, are to be regarded as subjects which have not attained their complete development.

There exist in the Bassin d'Arcachon 3,317 parcs, giving employment to 3,394 persons, and occupying an area of 3,836 hectares. The pro-

ducts during the season of 1873–'74 rose to 42,542,650 oysters of 5 centimeters in diameter; during that of 1874–'75, to 112,705,233 oysters of the same dimensions; and during that of 1875–'76, to 196,885,450. The value of the oysters sold in 1875–'76 was 3,941,309 francs.

I have now arrived at the end of my work. I have doubtless sometimes forgotten to notice establishments well worthy of interest, and localities where, as at Tréguier and at Paimpol, the oyster-cultural industry is prosperous, without, however, offering to the observer any new facts to study or any useful indications to report. I would not say more, but I do not wish to close without referring to the realization this year of the fruitful idea which the department of the marine, always in quest of wise progress, has steadily pursued—the idea of the transformation of the salt marshes into claires for the growth of the oyster. If, Monsieur the Minister, the attempts that your administration has so happily undertaken at Croisic have an issue definitely favorable—and the success of this first season causes me to hope for it—a new and brilliant future is reserved for oyster culture.

The conversion of salt marshes into oyster establishments will, in fact, insure a large outlet to that excess of production which embarrasses each year the oyster-culturists of Arcachon and of Bretagne.

It will be a beneficence, moreover, which our western population will owe to the marine, which has already done so much for them; and our whole country will find some profit, when these marshes which the salt industry has abandoned recover in a new way their ancient prosperity.

Permit me, Monsieur the Minister, before closing this report, to address my grateful thanks to MM. the commissaries and agents of the marine, with whom I have been brought into intercourse. I owe this public testimony of having always found in them the most zealous desire to facilitate my task, joined to that refined courtesy of which the marine has preserved the tradition.

With the expression of my gratitude, be pleased, Monsieur the Minister, to accept, etc.

PARIS, *December* 29, 1876.

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XXII.—REPORT ON THE CONDITION OF OYSTER-CULTURE IN FRANCE IN 1881.*

By Dr. P. Brocchi.

ANALYSIS.

By a decision, dated the 30th June last, the minister of agriculture and commerce, in accordance with a request made some time past by the oyster-cultivators of the Breton district, and with the desire formally expressed by the senatorial commission upon re-stocking the waters, has instituted a course of oyster culture and marine pisciculture in the laboratory founded by Coste at Concarenau (Finistère).

This course, intrusted to M. Brocchi, teacher of zoology at the National Agricultural Institution, was inaugurated on the 5th of September, and has been continued during one month.

Independently of oral instruction, M. Brocchi is charged with the duty of making researches in connection with the important questions to be dealt with in the course. He has just addressed to the minister his first report upon the observations made by him, and upon the actual condition of oyster-culture, which is subjoined.

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* Translation by T. H. Farrer of a report made to the minister of marine in France, by M. Brocchi, relative to oyster-culture on the shores of the Channel and of the ocean, and published in the *Journal Officiel de la République Française*, of the 8th of November, 1881 (in continuation of Parliamentary Paper No. 220, of session 1877.)

PARIS, *October* 30, 1881.

MONSIEUR LE MINISTRE: The preparation for the course of oyster-culture, which you have been so good as to intrust to me, has led me to visit the principal centers of oyster-culture in France.

I feel it my duty to render you an account of what I have had an opportunity of observing during my trip, and to lay before you the actual state of oyster-culture in our country. This industry, which is so new and so essentially French, has made rapid strides.

It is not for me now to give the history of oyster-culture; but suffice to say, its origin is of recent date. In fact, it was not until after the publications and the experiments of M. Coste (1856–1858) that the attention of the inhabitants of our coasts was attracted to the possibility of rearing oysters artificially. These experiments, to which the state devoted considerable sums, produced great effect. M. Coste, with an enthusiasm perhaps somewhat exaggerated, but productive of definite and happy results, announced that a new source of wealth was opened up to France.

The experiments, conducted simultaneously in the ocean and the Mediterranean, proved for the most part failures. On the other hand, and this has been too much overlooked, the experiments in the basin of Arcachon were crowned with success. Since then the stimulus has been given, and the industry of oyster-culture has not failed to make rapid progress.

Oyster-culture comprises two very distinct branches; one being production, and the other rearing and fattening.

Production aims at the collection of the embryo oysters, and in this way saves a vast number, which but for the intervention of man would be lost. It is well known that at the moment of its birth the young oyster is provided with locomotive powers, enabling it to swim in the midst of the sea.

After drifting for some time, the young oyster fixes itself on some extraneous body, loses forever its locomotive organs, and becomes the mollusk so well known. But these embryo oysters cannot fix themselves indifferently upon any bodies coming within range.

These bodies must be sufficiently smooth and clean. It happens, therefore, that in the natural course of things, a great quantity of these minute beings, the spat, not finding any objects to which to become attached, falls to the bottom of the sea and perishes. Indeed, that portion which has become attached under favorable circumstances is for a long period exposed to many dangers.

With the view of obviating these inconveniences, the oyster-culturists lay down in the vicinity of natural beds different bodies, designated by the name of collectors, which are intended to collect and preserve the spat. When the spat has become sufficiently developed it is detached, taken off, and given over to the rearer.

Rearing consists in placing the spat in the best conditions possible, so

that it may grow rapidly, and, so far as can be, be sheltered from the attacks of its natural enemies. Then comes the fattening, that is, the investing the oyster with those physical conditions which render it a luxury for the table.

I must now examine in succession the most important centers of production and rearing.

The two districts in France in which production is attended to on a large scale are: 1. Arcachon; 2. Le Morbihan.

BASIN OF ARCACHON.

In 1863, the industry of oyster-culture did not exist in this basin. At this epoch, in fact, one of our most distinguished pisciculturists, M. Chabot Karlen, published a report upon this part of France. From this interesting work it will be seen that the production of oysters was absolutely neglected in the basin. It is right to add that at that time M. Chabot foresaw the possibility of rearing oysters "in the wide water on the Crassats."

Oysters, however, existed in a natural state in this basin. Here, nevertheless, as everywhere, ignorance and want of foresight had produced bad results. The natural beds were silted up with mud, and the oysters were rapidly disappearing.

Under these circumstance it was that M. Coste resolved upon the establishment of some model *parcs* in this district. Three spots were selected on the surface of the basin, and here the success was complete. Thus one of the new *parcs*, that of Lahillon, 4 hectares in extent, furnished in 1866 more than 5,000,000 of oysters. Now when the operations were commenced in 1863 on this spot, there was nothing but mud. After cleaning the ground, 400,000 oysters were laid down in 1865, and, as I have just observed, the return the following year exceeded 5,000,000.

Such examples were well calculated to make impressions upon the coast population; in consequence, applications for concessions began at once to multiply, and, as I shall presently show, continued to increase.

Some years later the state, perceiving that its example had failed, conceded its model *parcs* to the central society of shipwrecked mariners; but a certain extent of oyster beds was reserved, and serves to supply with spat the surrounding concessions.

The beds so reserved occupy an area of 200 hectares; no fishing is permitted except at intervals of about three years, nor unless a commission representing the fishermen and the cultivators has expressed itself favorable to the fishing.

The marine administration takes great interest in this reserve. Every year 240 *mètres cubes* of small shells are thrown on the surface of these *parcs*, and form in this way natural collections. At the time of the last fishing (1879) this reserve had furnished 25,000,000 of oysters, representing a value of about 250,000 francs. In the month of April, 1881, when

I had the opportunity of visiting these beds, they were covered with fine oysters, and appeared to me to be in excellent condition.

The collectors used at Arcachon consist almost exclusively of tiles previously limed and disposed in hives.

About 10,000,000 of tiles are laid down every year; the most favorable moment for the operation appears to be from the 12th to the 15th of June. The hives remain in position until the month of October; some cultivators, however, allow the collectors to remain all the winter in the basin. This practice is attended with danger, as the spat may be destroyed by the frosts. Anyhow the young oysters are placed either in the *claires* or in the boxes. The *claires* of Arcachon have been too often described to make it necessary for me to do so now.

I shall, however, call to recollection that their depth varies according as they may be intended to receive the spat when detached, or the tiles to which the young oysters are still adhering. As a fact, a certain number of cultivators allow for some time the spat to develop itself on the tiles themselves.

The use of boxes is general at Arcachon. Still, as these engines are somewhat expensive, some cultivators have for economical reasons given up their use. On the other hand, some establishments possess a considerable number. In April last, for instance, 4,000 of these might be seen in one *parc* alone.

The present occasion does not seem fitting for entering into the details of the working arrangements. I desire solely to bring under your notice the proof of the importance of oyster-culture in this part of France.

The following figures, for which I am indebted to the extreme courtesy of M. Lhopital, commissary of marine, are in this point of view specially interesting:

Résumé of oyster operations in the basin of Arcachon.

Year.	Number of parcs.		Number of oysters exported.	Value.	Average price per thousand.
	Conceded.	Existing.			
				Francs.	*Francs.*
1865	297	297	10, 584, 550	338, 705. 00	40
1866	4	301	7, 852, 000	282, 070. 00	40
1867	39	340	4, 921, 210	191, 175. 00	16
1868	94	434	8, 599, 675	319, 186 35	37
1869	30	464	10, 145, 687	419, 784. 00	45
1870	21	485	6, 541, 140	352, 666. 12	58
1871	276	761	4, 897, 500	268, 332. 50	55
1872	371	1, 132	10, 796, 740	537, 515. 00	50
1873	106	1, 238	25, 711, 750	1, 159, 397. 00	41
1874	1, 175	2, 413	42. 542, 650	1, 745, 050. 00	45
1875	626	3, 089	112, 715, 233	2, 817, 630 00	25
1876	306	3, 345	196, 885, 450	3, 941, 309. 00	20
1877	301	3, 646	202, 392, 225	4, 456, 288. 00	22
1878	285	3, 931	176, 500, 225	4, 426, 500. 63	25
1879	184	4, 115	160, 197, 275	3, 944, 241. 88	25
1880	144	4, 259	195, 477, 357	4, 254, 465. 64	25

On examination of these figures it will be seen:

1. That the number of the *parcs*, which in 1865 was only 297, amounted in 1880 to 4,259.

2. That during that period the number of oysters exported rose from 10,584,000 to 195,477,375, representing a value of 4,254,465 francs.

3. That from 1870 to 1880 the number of oysters exported has exceeded one milliard, and it must be remarked that the oysters cannot be sold until they have obtained a minimum diameter of five centimeters.

It will be seen that the average price per thousand has greatly diminished of late years. This is due to the great quantity of Portuguese oysters introduced now into the basin of Arcachon. And here I must not pass over in silence the sensation which has been caused in the ostricultural world in consequence of the introduction into our waters of Portuguese mollusca.

Some distinguished oyster-culturists have, in fact, advanced the opinion that the Portuguese oyster might cross with the *Ostrea edulis*, and by altering its purity diminish the value of our indigenous oyster. They even announced that they had observed unequivocal traces of this hybridization upon oysters coming from Arcachon.

Among the cultivators at Arcachon this announcement caused an emotion all the more lively as one of the inspectors of fisheries in England had induced his countrymen to purchase no more oysters coming from Arcachon.

The mollusk known under the name of the Portuguese oyster does not belong to the same genus as our indigenous oyster. While the latter is included in the mollusca belonging to the genus *Ostrea*, the former takes its place among those constituting the genus *Gryphæa*, the species *Gryphæa angulata* Lamarck. In other words, the Portuguese oyster is not an oyster in a zoological point of view.

To afford some base for the allegation of hybridization between the two mollusca, it would be necessary, in the first place, to prove that zoologists have been mistaken in creating these two genera, and that Lamarck was in error in separating the *Gryphæa* from the oysters properly so called. In fact, in the present state of science, it is impossible to admit the crossing of two species belonging to different genera. All that we know, on the contrary, is opposed to the possibility of such a hybridization.

I repeat, then, until it has been proved that the genus *Gryphæa* should be omitted from our classifications, the cross between the mollusk of the Tagus and our edible oyster cannot be admitted.

Even allowing the identity of genus of the two mollusks, the characters mentioned by the partisans of hybridization do not appear to me to possess much scientific value.

These characters consist merely in the color of the shell, and no one can be ignorant of the extent to which the colors may vary of animals

belonging unquestionably to the same species. Finally, to be silent on no point, I will add that, from the experiments of MM. de Montaugé and Bouchon-Brandely (experiments which do not seem to me to have been conducted with sufficient scientific precision), it would appear that the spermatozoa of the Portuguese oyster cannot fecundate the ova of the *Ostrea edulis.* I can affirm that, during my stay at Arcachon, I never observed any fact which would make me believe in a change in the oyster produced in that district.

To sum up, I do not believe in a cross between the two mollusks; but I must add that the introduction into our waters of the Portuguese oyster does not strike me as unattended with danger. It is known that, when two species are compelled to live side by side in a limited space, there springs up between them what a celebrated naturalist has called the struggle for existence. This struggle must, sooner or later, end in the discomfiture and disappearance of the weaker species. Under these conditions if the *gryphœa* and the ordinary oyster are brought together, the latter must necessarily succumb.

The Portuguese mollusk is unquestionably more robust, more enduring, and, I should say, more prolific. The facility with which it propagates its species is really very remarkable.

It is known how the Portuguese oyster took possession of a portion of our coasts: a few hundreds of them having been accidentally brought to the embouchure of the Gironde soon formed considerable beds. Even this year I have been able to see collectors placed on the shores of the Isle of Oléron, covered almost exclusively with Portuguese spat.

I think, therefore, that in the generality of cases the culture of the *graphœa*, if carried on in the vicinity of *parcs* of ordinary oysters, may lead to serious evils. And yet I saw nothing at Arcachon leading me to think that the Portuguese oyster would supplant the ordinary oyster.

Here is, in addition, the very disinterested testimony of M. Lhopital, commissary of marine, to whom I had imparted my fears on seeing the daily increase in the introduction of the Portuguese oyster into the basin of Arcachon. He wrote to me recently as follows:

"Previous to the question of hybridization that of the entire occupation of the collectors, by the Portuguese oysters, had produced commotion among the maritime population of Arcachon. Some *parqueurs* had even demanded that the introduction of these oysters into our waters should be absolutely prohibited, and in the beginning of 1878 the minister directed an inquiry into the matter.

"It was ascertained that the danger apprehended was not serious. It is more than twenty years since enormous quantities of Portuguese oysters were introduced into the basin of Arcachon, which came either directly from the mouth of the Tagus or from the Bay of Corogne, or from England, or the embouchure of the Gironde. Well, with perhaps the exception of one or two years, it has been remarked that the repro-

duction of Portuguese oysters has been but trifling. The collectors detached this year may be said practically to have had none on them; and I have had much trouble in finding a few specimens on the reserved beds."

M. Lhopital attributes this failure in the reproduction of the Portuguese oyster in the basin of Arcachon to the purity of the waters and the absence of mud.

I am very much disposed to accept the explanation given by the commissary of marine. It is, in fact, to be remarked, that, wherever the Portuguese oyster is seen to propagate rapidly, there the presence of mud will be found in a state of suspension in the water. Still, it seems to me that the oyster-cultivators of Arcachon should take some precautions, and watch attentively what is going on in their *parcs*. A change in the currents would quite suffice to load the waters with mud and cover the collectors with the spat of the Portuguese oysters. I am not of opinion, however, that the state should interfere in this question otherwise than by giving advice.

Such, then, at the present time is the condition of the oyster industry in the basin of Arcachon, a condition which is certainly remarkable and worthy of fixed attention.

MORBIHAN.

Another important center for the production of oysters exists on our Breton coasts. It is known under the name of the Oyster Basin of Auray.

The cultivation of oysters in this region is of recent date. It is now fifteen or sixteen years since the first collectors were placed in the rivers of Morbihan. The center of the operations is to be found in the rivers or creeks which run into or open out in the Bay of Quibéron. The oyster-breeding establishments, in going from west to east, occupy successively the Creek of Po, the Trinity River, the Creek of St. Philibert, and the Auray River.

Natural beds of oysters exist in most of these rivers. The most important are those in the Auray River, which are about 22 kilometers in length, and those of the Trinity and Saint Philibert Rivers, which extend for about 15 kilometers.

Unfortunately these beds are in bad condition. This year they have been carefully explored by dredging, and the results obtained have been far from satisfactory.

Subjoined is a table showing the results of oyster fishing in the district of Auray from 1876 to 1881:

AURAY RIVER AND DEPENDENCIES.

Years.	Number of boats.	Number of men.	Number of women.	Duration of dredging.	Quantity of oysters dredged.	Average price per thousand.	Total produce of sale.
				h. m.		Francs.	Francs.
1876	594	1,782	....	20 30	19,974,000	21.65	432,341
1877	623	1,664	332	13 0	13,343,000	19.75	263,652
1878	694	1,852	448	15 45	27,145,000	15.75	427,841
1879	782	2,183	447	8 45	11,173,000	16.70	186,670
1880	809	2,379	491	9 30	8,283,000	20.40	175,263
1881	882	2,516	445	15 0	11,061,000	13.70	157,645

TRINITY RIVER.

Years.	Number of boats.	Number of men.	Number of women.	Duration of dredging.	Quantity of oysters dredged.	Average price per thousand.	Total produce of sale.
1876	133	429	....	10 30	2,042,000	17.00	31,722
1877	115	273	....	11 40	2,558,000	22.20	50,232
1878	154	400	108	7 40	2,206,000	22.50	49,591
1879	135	418	101	6 20	1,058,000	22.00	23,330
1880	88	198	79	4 15	257,000	34.00	8,737
1881	83	167	112	4 50	601,000	24.00	14,670

If these figures are referred to one scale, *i. e.*, to the number of oysters obtained by one dredger in an hour, the following are the results:—

AURAY RIVER.

		Oysters.
1877.	One dredger in one hour produces	411
1878.	One dredger in one hour produces	747
1879.	One dredger in one hour produces	485
1880.	One dredger in one hour produces	315
1881.	One dredger in one hour produces	262

TRINITY RIVER.

		Oysters.
1876.	One dredger in one hour produces	453
1877.	One dredger in one hour produces	453
1878.	One dredger in one hour produces	712
1879.	One dredger in one hour produces	566
1880.	One dredger in one hour produces	322
1881.	One dredger in one hour produces	444

From the above it will be clearly seen that the beds are becoming less productive; it is true that in the Trinity River the average revived in 1881, but when it is considered how low the totals have been (in 1881 the total number of oysters dredged was only 601,000), the averages are not very accurate. One portion of a bed, in fact, after remaining undredged for several years, may yield a great quantity of oysters, and thus raise the average considerably.

In spite of these unfavorable conditions the production by the rivers of Auray is not unimportant, as the following figures will show:

Years.	Marketable oysters exported.	Spat.
1876–'77	7,260,000	46,056,000
1877–'78	8,094,000	46,004,000
1878–'79	7,684,000	40,526,000
1879–'80	10,599,000	37,618,000
1880–'81	33,325,000	155,418,000

Some observations are now necessary. In the first place it is to be remarked that these figures are necessarily below the actual fact. In obtaining them regard must be had to the alleged practice of certain oyster-cultivators of concealing the actual amounts through fear of their patents being raised. The number of oysters exported either from Brittany or from other centers of oyster-culture is considerably higher than that stated by those interested.

It must also be remarked that the spat is furnished not merely by the natural beds, but, also by important reserves, which are owned by numerous oyster-cultivators. This explains how, in spite of the precarious state of the natural beds, the yield of young oysters continues to be abundant.

The figures which I have the honor to submit to you will further show the sensible increase in oyster production in the basin of Auray. In 1876–'77, the number of oysters exported was only 7,260,000. In 1880–'81 it had reached 33,325,000.

The oyster-cultivators of this district have to contend against a natural obstacle—the mud which abounds in the rivers and creeks of Morbihan. Thanks to an ingenious disposition of collecting tiles, this obstacle has been surmounted. The collectors if disposed in hives would become rapidly covered with mud; this method has consequently been discarded in favor of that which is called the *bouquet* or *champignon.*

The tiles are pierced with one hole at each extremity, and are joined some 12 or 14 together by means of wire. They are then attached firmly to the head of a stake, 1 m. to 1 m. 50 in length, which can be easily fixed in the ground.

This system, the first idea of which is due to M. Leroux, has the double advantage of preventing the accumulation of mud on the collectors, and of rendering the fixing of these engines easier and more rapid. The time which appears to be the most favorable for laying down the tiles is in Brittany from the 1st to the 20th of July. This date is one month later than that in which, in the basin of Arcachon, this operation is conducted. The difference is easily explained by the difference in temperature at these two points on our sea-coast.

The use of boxes is not so frequent in Brittany as at Arcachon. For this there are several reasons, the most important of which is the follow-

ing: While the oyster-cultivators at Arcachon are unable to export their oysters until they have attained the size of five centimetres, the Bretons are at liberty to sell, generally, the oyster while in the condition of spat, and are not bound to occupy themselves with the rearing. The question of price is an important one, especially as oyster culture is still in its infancy in this district.

A certain number of oyster-cultivators in Brittany substitute, to some extent, for the use of boxes, the use of what is termed *l'huître à tessons*. This expression may be thus explained: the young oysters are left for a certain time on the tiles, and then, instead of detaching them, the collector itself is cut into fragments. Each oyster adheres to one of these fragments. This system, which was invented by one of our most distinguished oyster-cultivators, Dr. Greppy, possessed the advantage of placing the oyster in a better position for resisting the attacks of its natural enemies; the crab, for instance.

Other cultivators allow the oyster to remain fixed to the collector fo two years. They place the tiles, when covered with spat, in the emerging basin or merely in the *claires*. The loss attending the operation of detachment is considerable; but some oysters are checked in their growth owing to their pressing too closely one against the other.

I have no occasion now to enter into further details, but will proceed to consider the centers for rearing and fattening. The most important centers for fattening will be found at Marennes and la Tremblade.

Marennes has been noted for many years for the production of green oysters; but for some time past this locality has supplied commerce with large quantities of oysters which have been imported from all parts of France and laid down for the purpose of rearing and fattening.

The following figures, for which I am indebted to the kindness of M. Senné-Desjardins, show the importance of this trade at Marennes.

YEAR 1880–'81.

The number of oysters imported into Marennes, was 190,000,000, of which 130,000,000 were introduced into *viviers* and *dépôts*, and 60,000,000 were introduced into *claires*.

Of the 130,000,000, there were 40,000,000 Portuguese, and 90,000,000 French oysters.

YEAR 1880–'81.

Oysters exported from Marennes, 151,000,000. Of this number 54,-000,000 Portuguese, and 47,000,000 French, went from the *viviers* and *dépôts;* 50,000,000 were produced from *claires*. Marennes has sent out this year 151,000,000 oysters, representing a value of 5,900,000 francs. I should point out that, for the reasons already stated, these figures should be raised rather than lowered.

Marennes, then, it will be seen, in addition to the oysters reared in the *claires*, carries on an important trade in oysters. Of the 190,000,000 imported in 1880–'81, 60,000,000 only went into the *claires*.

It is also impossible not to perceive how the trade in Portuguese oysters has developed. Of the 151,000,000 of oysters sold this year 54,000,000 were Portuguese.

I must now pause for an instant to dwell on the care bestowed by the cultivators of this district on their *claires*. Not that I desire now to bring forward facts already well known, but because I conceive that the administration of the *claires* of Marennes might be imitated with advantage in other centers of oyster cultivation.

The *claires* are placed on both banks of the Seudre; they are not, as at Arcachon, submerged at each tide, but only at spring tide. Some are even a long way from the banks of the river. They are so worked that some are in a state of preparation whilst others are in use.

The preparation of the ground generally goes on in March. It includes two operations: *gralage* and *la mise en humeur*.

Gralage has for its object the purification of the soil by evaporation; it lasts from six weeks to two months. The *claires* are cut; that is, the water is no longer kept in them, and they are not visited by the sea except at high tides. They dry in the sun. When the *claire* is *gralée*, or, in other words, covered with a well-drained bed, 15 days are spent in bringing it into condition. A small quantity of water is allowed to enter, and the retention is resumed.

The dry crust dissolves in the water, produces a kind of effervescence, and the final result is a uniform deposit on the *claire* of a creamy precipitate, which is called *humeur*. The oysters may now be laid down, and they begin to turn green at the end of a fortnight.

This operation must be conducted every year. The oysters are laid down at the bottom of the *claire*, and placed at a proper distance from each other by hand. About 5,000 are placed in an area of 33 acres.

Down to the present time the industry of Marennes has been confined to rearing and fattening. It is to be hoped that before long production will be introduced into this locality. The commissary of marine of this quarter is indeed actually engaged on this question.

Having resided for a long time at Auray, M. Senné-Desjàrdins is conversant with every question pertaining to oyster-cultivation. His intelligence and the devotion he displays in all his duties allow of the hope that this new enterprise will be a success. On many other points of our sea-shore the rearing of oysters engages attention.

I do not consider it desirable to pass in review all the localities where the industry is exercised, but I will speak a few words respecting one of these centers which, I think, possesses special interest.

I wish to speak of the *parcs* established some time since at Courseulles. They are situated in the vicinity of the Seulle, a small river which runs into the sea at this point of our Norman coast.

The canals which communicate with the sea and the oyster basins are so disposed that when the sea rises it cannot, during neap tide, get beyond the sluice gates; consequently, during that period the sea water

is not renewed. During the spring tide, the salt water can enter the canals, but only after having mixed with the fresh water of the Seulle. Pure sea water never enters the *parcs*.

It has been long ago remarked that the oysters placed in the basins of Courseulles fatten rapidly and acquire a particularly delicate taste.

I have thought it important to bring forward these facts, because, from all I have learned and from all I have seen, it appears to me that the blending of fresh and salt water is a condition which, if not indispensable, is, at all events, one of the most advantageous for the fattening of the oyster. In the same way the currents influence, in an unquestionably beneficial way, the growth of the oyster.

French oysters transported to the mouth of the Thames, where the water is nearly fresh, soon acquire the qualities which recommend them to the gourmet. Many of the oysters sold as Ostend oysters have no other origin.

It has further been remarked that oysters taken in the bay of Chesapeake are much fatter than those dredged on other parts of the American coast. It is very probable that this favorable feature is due to the numerous streams of fresh water which run into the bay.

I believe, then, that the fattening of the oyster ought to be recommended on all parts of our coast where natural conditions render possible a blending of fresh with salt water.

At Lorient several establishments, where this desideratum has been realized, are on the high road to prosperity. These examples might easily be multiplied.

For some time past the rearing and fattening of oysters has engaged attention in the basin of Auray.

The cultivators here have to contend with a difficulty arising out of the want of consistency in the soil. But their industry has surmounted this unfavorable condition by macadamizing the mud. For this purpose, they place on the surface of the soil sand and stones, which eventually form a sufficient resting bed.

I believe that the cultivators of Brittany will eventually raise oysters by these means But I fear that fattening in this district is not followed by good results. In fact, except in a few favored spots, the want of fresh water will be a serious obstacle to perfect success.

I need not, I think, dwell more upon this portion of my report. But I desire to draw your attention to this fact, that, while oyster cultivation is relatively a success on our ocean-bound coasts, it is, so to say, not represented upon our Mediterranean shores.

All the attempts made formerly by M. Coste have been without reslt. I consider it useless to recur to these unfortunate experiences, but there is some degree of interest in the inquiry whether oyster-cultivation ought to be definitely abandoned in this part of France.

At present several species of oysters live in the Mediterranean. These are as follows:

1. *Ostrea edulis and its varieties.*—This oyster appears to experience difficulty in existing in the Mediterranean, except in that portion of the sea which washes our coasts. It never forms beds. Some solitary specimens may be found on the muddy bottom, at a depth of from 30 to 60 meters, outside the embouchure of the Rhone.

2. *Ostrea cyrnusii.*—This oyster bears a great resemblance to the Edulis. It is distinguishable more particularly by the greater length of the hinges. It is found in the brackish water on the east side of Corsica.

3. *Ostrea cochlear.*—I only cite this species as a matter of form. It is a very small and rare oyster, living at a great depth (100 to 140 meters). In a comestible point of view it has no interest.

4. *Ostrea stantina.*—This is a small species, tolerably abundant at Toulon, but more rare on the rest of our coast. It seems to prefer impure waters.

Of these species, two only offer any interest in a cultivator's point of view. These are the *Ostrea edulis* and the *Ostrea cyrnusii.*

All the experiments which have been made down to the present time have been with regard to the *Ostrea edulis.* M. Coste used for his operations oysters produced by the coast of Brittany. As already remarked, this species does not propagate itself readily on our Mediterranean coasts. Many zoologists attribute this fact to the water of this sea being too salt. However this may be, I think that new efforts should be made, and that this time the oysters from the coasts of Corsica should be employed, *Ostrea cyrnusii.*

I am inclined to believe that this species would afford good results if introduced into the marine ponds so numerous along our southern coasts, to which I have already had the honor to draw your attention. Such are the chief points to which I was desirous of inviting your attention. To sum up, the state of oyster-cultivation in France is sufficiently satisfactory.

This new industry has not only succeeded in sending a great quantity of these mollusca to the markets of our country, but it likewise exports a considerable number. Thus, last year French cultivators sent to London 28,000,000 of oysters. Belgium receives several millions every year.

Nevertheless, I am convinced that oyster-cultivation might be more fully developed if it were protected from certain dangers by which it is menaced, some of which are really of a grave character. Permit me to lay before you these dangers, as well as the means which, in my opinion, should be employed to combat them.

I have already had occasion to refer to the rapid deterioration of the natural beds. This, without question, is the most grave danger, in any way, of oyster-cultivation. It is, therefore, of moment to trace the causes to which this state of deterioration may be ascribed.

Two main facts may be brought forward. In the first place, it is

necessary to refer to the thefts committed on the beds, which are of incessant occurrence.

These thefts are committed openly. The thieves not only attack the reserved beds, but may be seen to take up their position on *parcs* owned by individuals, breaking the *claires*, and taking away their contents. The employés of the marine, though well-intentioned and of undoubted loyalty, are not in a position to meet the depredations of these undaunted robbers.

As a fact, the means at the disposal of the maritime authority are not, in the generality of instances, adequate for the pursuit and capture of the poachers. This class of pirates being furnished with swift craft, having an admirable knowledge of the grounds upon which they are operating, and always taking advantage of rough weather, cannot, as a rule, be caught.

The coast guard will never be able to act efficaciously until they have steam sloops at their command. This expedient, which has already been recommended by M. Robin, a member of the Senate, seems to me to be the only way of insuring an effectual surveillance.

But this is not all. When, under fortunate circumstance, the thief has been captured, the punishment awaiting him is really ridiculous. One may see a man who, in a few hours, has stolen oysters worth two or three hundred francs condemned to pay a fine of five francs!

Another very important cause of the deterioration of the natural beds is the overdredging. Before reaching a marketable size, the oyster requires a period of time which may be computed at two or three years. Now, on certain parts of our coasts, and especially in the rivers of Auray, dredging is conducted every year. True it is that fishermen are recommended to throw back under-sized oysters, but everyone must see that this is an ineffectual measure. It ought to be made imperative that dredging should not be conducted on the same bed oftener than every second or third year. Such is the practice at Arcachon, and I have had occasion to point out that the results are excellent.

A further cause of the non-development of oyster-cultivation, in Brittany, at all events, is the rent (to my mind too high), which is exacted from the concessionaires of the shore.

While at Arcachon the rent ranges from 30 to 45 francs the hectare, according to the position of the *parcs*, cultivators in Brittany pay no less than 100 francs for an equal area.

Now these shores are fit for no other purpose; they are simply mud banks, without any value whatever. The sum of 100 francs the hectare is more of the nature of regular rent than a concession.

Here, then, is a really high tax pressing heavily upon a new industry which, on every account, deserves protection and encouragement.

Besides the interest which this industry presents in itself, it is not to be forgotten that the oyster-cultivation occupies each year a great num-

ber of persons, women and children, who, but for it, would be without employment.

To sum up, I think it would be desirable to see Government take the following steps:

1. Place at the disposal of the coast guard a certain number of steam sloops, which are the only craft fit for pursuing with success the poachers on our natural beds.

2. Regulate the dredging of these beds so that no bed should be dredged except once in three years.

3. Recommend to the competent authorities increased severity in the repression of robberies committed at the expense of the cultivators.

4. Lower the rents exacted from the concessionaires of *parcs* in the Brittany district, in such a way that the amount of this tax shall not exceed that which is demanded from cultivators in the basin of Arcachon.

As regards the recommendations to be made to the cultivators, they will naturally find their place in the course which you have thought it desirable to institute.

The persons who are engaged in this industry have it, moreover, in their power to do much for themselves. With this consideration I would suggest the formation of companies for oyster-cultivation. The cultivators of Auray have entertained the idea of such co-operation. Their reunion, which took the title of company for the cultivation of oysters in the basin of Auray, has already afforded excellent results.

This company publishes monthly a report of proceedings, and it has likewise founded a museum of oyster culture which possesses great interest for all persons engaged on questions relating to the production of oysters. This example ought to be followed by all centers of oyster-cultivation. Such are the facts to which I was desirous of inviting your serious attention.

In conclusion, permit me to say how greatly I have been aided in my researches by the agents of the *administration maritime.* M. Broquet, lieutenant in command of the *Moustique*, the following commissioners of marine, viz, MM. Senné-Desjardins, Lhopital, Gestain, and Castelin, have obtained for me invaluable information.

If in this report I have succeeded in bringing together any facts of interest, I owe my success to the courtesy I have received from the gentlemen whose names I have just mentioned.

XXIII.—REPORT OF EXPERIMENTS IN THE ARTIFICIAL PROPAGATION OF OYSTERS, CONDUCTED AT BEAUFORT, N. C., AND FAIR HAVEN, CONN., IN 1882.

By Lieut. Francis Winslow, U. S. N.

The chronicle of the different successful efforts to artificially impregnate the egg of the oyster is short. In 1879, Dr. W. K. Brooks succeeded with the American species (*Ostrea Virginiana*). In 1880, following his methods, I succeeded with the Portuguese (*Ostrea angulata*), one of the European species. During the same season Mr. J. A. Ryder made another attempt, likewise following Brooks's methods, with our domestic oyster, and I have no doubt, though I have seen no published accounts of other experiments, that since the initial trial in 1879 Dr. Brooks has had many followers both in this country and abroad.

The history of these several efforts to raise the oyster from the egg by means of the artificial impregnation of the ova has been before the public for some time. Dr. Brooks' experiments are detailed in the Report of the Maryland Fish Commission for 1880, and in the Studies of the Johns Hopkins Seaside Laboratory for the same year. Mr. Ryder's experiences and my own are published in the Report of the Maryland Fish Commission for 1881. All these are so well known that it is unnecessary to here recapitulate even their principal features; but one point is worthy of notice. Each experiment has attained about the same degree of success, or perhaps it would be better to say has failed at nearly the same point. The egg has been impregnated and the embryo maintained alive for various periods; but beyond a certain stage, neither Dr. Brooks, Mr. Ryder, nor myself have yet succeeded in keeping them.

The success of the initial experiment was so great, and the advance in oyster culture appeared of so much importance, that investigators, myself among the number, were perhaps too sanguine; possibilities appeared probabilities. We expected that as soon as a few changes were made in the apparatus, and methods somewhat more nearly perfect were introduced, we would be able to produce young oysters with the same facility as young shad, and with a greater surety with the former of reaping the reward of our labors, than was possible in the case of the latter. But after my experience of the past spring and summer I am convinced that it will require a series of pains-taking experiments, extending over considerable time and conducted under many dissimilar

conditions, before the artificial production and culture of the oyster is made a matter of practical importance.

Both Brooks and Ryder in conducting their experiments naturally considered first the scientific aspects of the case. Their training and profession led them, unintentionally perhaps, to regard the practical application of their discoveries as of less moment; my own feeling was the exact opposite. The great interest on their part centered in the process rather than in the result; on my own, in the result rather than in the process. Their desire was to raise one oyster, mine to raise many. But feeling that they were more competent than myself to accomplish the result they had in view, and knowing that one oyster must be raised before any method of raising many could be perfected, it appeared to me very desirable that I should associate myself with either or both of those gentlemen, that in my effort to obtain results of practical value I might have the assistance of their counsel and the benefit of their larger experience. Accordingly, during the winter and spring I had several consultations with Dr. Brooks and Mr. Ryder, and as the former proposed to continue his experiments with the oyster during the spring at Beaufort, N. C., and as that locality offered facilities for the work not possessed by others, I determined to join Dr. Brooks as early as possible and work in conjunction with him as long as the condition of the oysters permitted, subsequently joining Mr. Ryder in the Chesapeake or at Saint Jerome, should he continue the prosecution of his researches.

The want of success which had attended all previous experiments appeared to be due to the deficient supply of water to the aquaria. Various methods of obviating this difficulty had been devised by Dr. Brooks or Mr. Ryder, and are detailed in their accounts of their experiments, but no method had proved successful. The embryo was too minute to permit the removal of any of the water without carrying along the animal, and consequently the supply was limited to the capacity of the jar or receptacle. Being unable to afford the large quantity of water necessary or apparently necessary to the life of the young oyster, it occurred to Dr. Brooks and myself that we might overcome the difficulty by adding to the water already in the aquaria an inordinate amount of the several constituents of the sea-water which were supposed to be essential to the development of the embryo.

The study of the natural conditions under which the oyster propagates and lives, together with past experience, led us to the conclusion that the principal obstacles would be removed by increasing the supply of oxygen and carbonate of lime, with, perhaps, the addition of artificial currents of air or water through the jars. We were of the opinion that, working under the above conditions, and with care in the manipulation of the eggs, we would make a considerable advance towards the solution of the problem; but a very brief experience convinced us that it was more than probable that the supply of a large amount of food was also an essential factor in the equation, and as we proceeded with the

experiments we also ascertained that several conditions which we had supposed were necessary to success might be safely ignored. Probably had the experiments been conducted simply with the view of determining the effect of the various conditions upon the development of the eggs and embryos, we might be able to speak more definitely and with more authority as to the necessity of supplies of oxygen, lime and food; of the necessary temperature and density to be maintained; of the rate and manner of development under different circumstances and of other matters of interest and value. But that end was not our main object; the determination of those questions appeared to be of secondary importance and only incidental to the work. In the order of their relative importance we proposed to accomplish, if possible, the following things.

1st. To raise one oyster up to the time of attachment.

2d. Guided by the experience attained, to perfect a method by which oysters could be raised from the egg in sufficiently large numbers to make the process one of practical value.

3d. To determine the conditions necessary and favorable to growth.

While we were not successful in attaining either of the first two ends, yet some advance has been made and incidentally we have obtained information and gathered experience that throws additional light on the course to be pursued in the future.

I arrived at Beaufort, N. C., on the 23d of May, Dr. Brooks having preceded me some two weeks, and I remained until the 23d of June, when finding that it was difficult to get oysters in proper condition for experiment, and wishing to prolong the season as much as possible, I returned to Washington with the intention of proceeding thence to some point on Long Island Sound and continuing the experiments. I also wished to try the effect of placing a large number of embryo oysters, that had passed through the first swimming stage, on some defined and protected area, such as the private oyster beds of the Connecticut oyster-growers. The plan having met with your approval, I proceeded to New Haven, Conn., and remained in that vicinity about a month, continuing the previous experiments, and at the same time fertilizing as large a number of eggs as possible, and depositing them on one of the beds of H. C. Rowe & Co., of Fair Haven. I have not yet received information which will enable me to speak definitely as to the success of the latter experiment, but such as I have received points in a favorable direction. While at Beaufort and at Fair Haven the experiments were continuous and occupied every day and a good many nights. Every effort was made to solve the problem, and at the close of the season I regret to say I am as unable as at its commencement to state the causes which prevented success or indicate those which must operate to produce favorable results. It is hardly worth while to give a detailed history of a series of experiments that produced negative results only, or to describe at length appliances and apparatus that

were chiefly remarkable for failure, though both have their value in tentative work. I shall not therefore burden this report with such accounts, but confine myself to a statement of the methods and apparatus we found of assistance, and of the influence, so far as we were able to observe it, of the various natural conditions affecting the development of the egg.

1. *Selection of the oysters.*—This is a point of more importance than I had supposed. Even in the height of the spawning I found it necessary to use care in selecting the oysters from which I was to derive the generative matter, and it is especially necessary to use this care with regard to the males. At Fair Haven I have frequently hunted over thirty or more oysters before finding a male with the spermatozoa in an entirely satisfactory condition. The superfluous male fluid is difficult to get rid of after the eggs have been impregnated, and this difficulty is much increased when the spermatozoa are dead or immature; but unless removed they soon pollute the water. Bad eggs are of less trouble, but their removal is sufficiently embarrassing to make it desirable to use only those that appear entirely ripe. While experimenting on a large scale, with immense numbers of eggs, as I did at Fair Haven, the temptation is great, on account of the saving of time and labor, to take any and all oysters without exposing the contents of the generative organs to the microscopic examination; but I found by experience that it would not do to trust to subsequent manipulation for the removal of unripe ova and spermatozoa; such a course required in the long run more time and labor than the selection of good oysters would have done in the first place, and was not always entirely efficacious. I think the failure of some of the experiments, both at Beaufort and Fair Haven, was undoubtedly due, or partially due, to neglect of these precautions. At Beaufort we were sometimes compelled to take inferior oysters, but at Fair Haven it was possible at all times, with care, to secure a sufficient number entirely suitable for experiment; and if other investigators in this field are located near any large oysters area they should not experience any great difficulty in obtaining ripe animals throughout the spawning season. It must be remembered that the time of spawning or the ripeness of the oyster in any locality is dependent upon several conditions, the principal being the depth and density of the water, the shallow and brackish water oysters spawning first. I am of the opinion that even those oysters from the same spot will be found to be in various stages of ripeness, such having always been my experience, and, consequently, it is necessary to search carefully for unfit animals, even when the majority of the lot appear in an entirely proper condition. This refers, of course, to an experiment on a large scale, somewhat similar to my own at Fair Haven, where I used the generative matter of several hundred oysters nearly every day. Working on a smaller scale the experimenter would naturally use sufficient caution. Throughout the season, with large and small numbers of eggs under observation,

the large number of eggs which never advanced in development was constantly noticeable. Many had apparently escaped the attack of spermatozoa, and many more only advanced through the very earliest stages of segmentation. This was the case very frequently with the eggs taken from oysters that were, so far as could be judged, perfectly ripe, the eggs under the microscope appearing free from granular matter, well defined and of clean outline, well-shaped, and germinative vesicle obvious. The frequent recurrence of this circumstance leads me to believe that the eggs of even one oyster are not all ripe at the same time, though they may approximate to it. It seems very desirable that, as recommended by Mr. Ryder, the histology of the ovaries should be exhaustively studied, that the matter may be settled; its importance to future experiments and to practical work is too obvious to need comment. One other point may be mentioned in this connection. I found one female oyster at Beaufort and one at Fair Haven with the visceral mass, including the ovaries, filled with *Bucephalus cuculus*. I have not met with any similar case, and consequently, the evil must be exceptional; but that it is possible is certain, and that possibility is an additional reason for using care in selecting the ova for artificial impregnation, as the presence of *bucephalus* as well as infusoria in large numbers in the water of the aquaria will conduce to failure. Dr. Brooks, in his account of the initial experiment, has described the appearance of the generative fluids when in proper condition, and I need not duplicate his work. I only desire to impress my conviction that success or failure of experiments in this field is due, to considerable extent, to the care, or want of it, in selecting the oysters from which are taken the products of generation.

2. *Impregnation of the egg.*—The methods followed and advised by Brooks should be strictly adhered to. The males should be first treated, and care should be taken that not more spermatozoa is used than is necessary. One male will supply sufficient for half a dozen females, but it is better to use a larger number and only partially wash out the spermaries. In both sexes the ripe fluid is most easily removed, and though after the first washing there appears in the crystal or saucer a large amount of generative matter, yet most of it is probably unripe and had better be thrown away. A perusal of Brooks' notes on the structure of the generative organs will be sufficient to convince any one that the course I recommend will have its influence in preventing unripe ova or spermatozoa from getting into the aquarium jars; and, as I have stated, the insurance of this point is a matter of importance. The impression derived from Dr. Brooks' paper has been strengthened by the experience of the past season, and I am of the opinion that in several of the experiments I would have had more swimming embryos had I not had so many eggs; many never developing and only polluting the water.

In removing the generative organs, the time and labor expended in

getting rid of the mantle, gills, digestive tract, and fragments of the muscle is well bestowed. There is but little danger of an insufficient number of eggs being secured while the presence of fragments of the organs just mentioned, due to hesitancy in using the scissors and sacrificing large portions of the ovaries or testes, exerts a very deleterious influence upon the future development of the egg.

As soon as the generative organs of the male are removed they should be washed out in salt water. It is not advisable to defer this action for any considerable time and consequently only a few oysters should be treated. The spermatozoa soon dies if left exposed to the air and I account for the large number of males with dead cells which I noticed at Fair Haven, by my non observance on several occasions of this precaution. I was in the habit, at first, of opening thirty or forty oysters and removing the generative organs of all, before washing out the cells. As this required considerable time, and as at first I did not select the males for treatment before removing the eggs from the females, many of the difficulties I experienced in disposing of superfluous spermatozoa, and in securing thorough impregnation of the eggs, are due, probably to the above cause. With the females it is, so far as my experience goes, not necessary to use so much care. The principal precaution to be taken is in bringing the ova and spermatozoa in contact as soon as possible after the former have been exposed to the water. As Dr. Brooks points out, the eggs soon disintegrate after they are placed in the water if they are not attacked by the spermatozoa. To sum up, it is advisable to use a moderate number of oysters of both sexes, not to be over particular in securing the contents of the generative organs, to treat the males first and supply the spermatozoa with water as soon as possible, and to bring the two fluids in contact immediately after the eggs have been washed out of the ovaries. Ten or fifteen minutes should be the maximum time of the operation. Though the observance of these points precludes, to a certain extent, the manipulation of large numbers of oysters by one person, yet, so far as my experience goes, it seems essential to success. In the experiments conducted on a small scale, when I used care in all these particulars, I obtained proportionately much better results than when working on a large scale and using a hundred or more oysters; in the former case to accomplish the object I had in view every care was necessary; in the latter I sacrificed something to the supposed necessity of obtaining a very large number of fertilized eggs every day; but, after considerable experience with both methods, I am now convinced that a few oysters and eggs, carefully treated, will produce a larger number of embryos than when the number of oysters is so great as to preclude the observance of the most minute precautions.

The most satisfactory results were obtained when the two fluids, having been well mixed together and the fragments of mantles, gills, and organs allowed to settle, the contents of the tumbler were poured

off, and the sediment at the bottom *thrown away*. There is no other way of satisfactorily getting rid of the fragments of the various organs. I have strained the fluids through fine muslin, have squeezed them out of the generative organs with the hand instead of cutting them up, have even ground up the visceral mass in a coffee-mill; but I found no method so productive of good results as obtained by chopping the reproductive organs into a few pieces and washing them once or twice in a glass of salt water, allowing the glass to stand a few minutes and then pouring off the water containing the eggs and excess of male fluid.

After getting rid of the *debris*, the contents of the glass should be stirred frequently for ten or fifteen minutes and then allowed to stand quiet that the heavy, fertilized eggs may sink to the bottom. Only one precaution is here necessary; too many eggs must not be collected in one glass. The layer on the bottom should not exceed one-eighth of an inch in thickness, and a smaller number of eggs is preferable. I succeeded better when I used a large number of small glasses (tumblers) than when I used one or two large jars (trout hatching jars) for this part of the process, and not only were the results better but there was an appreciable saving in time, with the tumblers. The evils of the large receptacle are the same as those noticed when too many eggs were put in one tumbler. So much time was taken up by the eggs in sinking to the bottom after each renewal of the water, that spermatozoa were carried along with them, and the eggs after reaching the bottom were packed so closely together, and on top of each other, that they resembled a slimy mass of mucous, and could not be readily detached from the glass or from one another. Such conditions obviously hinder development and should be guarded against.

The removal of the excess of male cells and unripe or floating eggs is a simple matter of easy accomplishment. As soon as the eggs are at the bottom of the glass, siphon off the water and refill the tumbler. After the first two or three operations the eggs can be seen as a white cloud sinking through the water; ten minutes rest between the operations is quite sufficient time for the eggs to sink. If they do not descend in a solid mass, but "straggle" to the bottom, it is an indication that there are many but partially ripe or unimpregnated eggs in the lot and that the prospect of a successful issue to the experiment is slight. The water should be changed until, after the eggs have sunk to the bottom, it is perfectly clear. The investigator can then proceed to the next operation.

3. *Care of the eggs during segmentation.*—After the water in the glasses has been cleared, and all deleterious matter disposed of, it is of greatest importance that the eggs should have *room* for development; that is that they should not press upon or in other ways incommode each other. There are a number of other points of importance to be observed but I defer their consideration, for the present confining myself to features of the manipulation that must be common to all experiments.

If the eggs are in a thick layer on the bottom, only a few, comparatively, develop, and this fact consequently necessitates the use of shallow jars, or dishes, having a large bottom area, during this part of the process, or else some other form of apparatus which will produce the same desired result, viz, freedom from pressure. During the past season we accomplished this end, approximately, by placing the eggs when once free of *débris* and unripe eggs or excessive spermatozoa, in soup plates or large platters; at Fair Haven I used the largest dishes I could purchase and with good results. The principal point is not to overcrowd the eggs; it is better to err on the side of too much caution, sacrificing some of the eggs if necessary, rather than in the attempt to save all, run the risk of very many failing to develop. I also devised another method which gave fair results, and which appears susceptible of improvement. It consisted of a small glass funnel holding about a pint, and having a jet of air through a narrow orifice in the bottom. The water containing the eggs was placed in the funnel and a small stream of air, as little as possible, was forced up through the apparatus. The eggs by this means were kept constantly in motion, rising in the middle and sinking along the sides of the funnel. We got very good results from this appliance but I am not prepared to say that it succeeded very much better than the platters. A slight improvement in the form of the funnel would add to its efficiency; the nearer perfectly conical its interior form the better.

We did not find it necessary to add any water during the process of segmentation, but having once placed the eggs in the plates or funnel, we allowed them to remain undisturbed until the first swimming stage was reached. It is very important that when using the plates all the preparations for operations subsequent to the time of arrival at the swimming stage should be completed several hours before that event occurs. The plates must not be moved nor the eggs disturbed, else it will be impossible to avoid carrying into the second receptacle many undeveloped eggs. In using the cone, a rest due to cessation of the air jet for one hour or more was allowed, before any attempt to remove the swimming embryos was made.

Attention is called to Brooks' description of the development of the egg, in order that the significance of this latter point may be appreciated. The embryo swims at the surface but a comparatively short time; very large numbers of eggs never reach this stage and the swimming embryos must be separated from them before the disintegration of the former renders the water so impure as to insure the destruction of the latter. This removal is not always easy of accomplishment, but we succeeded, partially, by using two plates. In one was placed the eggs during segmentation, with water enough to nearly fill it. The second plate was arranged under the first, so that any overflow from the latter would fall into it. After the embryos began to swim the first plate containing them was overflowed, drop by drop, by means of a minute stream of water

falling on the edge of the upper plate. Each drop carried over many embryos, and after the lower plate began to fill and inspections of the overflow showed a diminution in the number of embryos, the plate containing the eggs was removed and either the contents thrown away, or a second resting period allowed in order that another lot might develop, in which case the operation was repeated. In using the funnel it was suspended over a jar or large beaker, and after the embryos began to swarm to the surface the air jet was reduced or cut off, and in the latter instance, a minute jet of water substituted. Originally the funnel was only half filled, and the water jet being small occupied one or two hours in filling the remaining space and at the same time kept up a gentle movement among the eggs. Care was necessary that the undeveloped eggs should not be thrown very near the surface so as to interfere with the swimming embryos or become mixed with them. After the funnel filled, the water jet caused a gentle overflow into the beaker, which overflow was continued as long as the number of embryos passing over justified it.

The sketches show the manner in which we arranged this very simple apparatus, though it is hardly of so complex a character as to require illustration; they may, however, be of assistance to others, and perhaps contain the germ of a method or appliance that will produce valuable results.

After the swimming embryos have been separated from the undeveloped eggs, their subsequent treatment involves the consideration of many natural conditions, all of which have more or less influence upon the success of the experiment; but as they also exert an influence upon the development of the eggs during segmentation, and as the life of the embryo does not, apparently, depend upon manipulation, I have considered it best to allude to the effect of varying natural influences, separately from those due merely to management of apparatus or generative fluids.

Influence of temperature.—While I am not prepared to say that the temperature of the water during the development of egg or embryo is the most important consideration, and while I do not wish to be understood as stating these following influences in the order of their relative importance, yet, so far as my experience goes, I am inclined to think that the extent of the influence of temperature is sufficient to cause it to rank at the head of the various causes affecting the success of the experiments. It is scarcely possible in an investigation conducted among so many and various affecting conditions, to eliminate sufficiently the influence of all others so that one may be able to speak definitely as to the remaining cause for success or failure; but after considerable experience I feel justified in coming to the following conclusions with reference to the effect of temperature.

a. The condition of the eggs is not only dependent upon the depth of water (or temperature) from which the parent is derived, originally,

but a very short exposure of the animal to water of an increased temperature caused a deterioration of the generative matter. I have tried to fertilize the eggs of numbers of oysters that had lain over night in the Quinnipiac River and invariably failed; the eggs in nearly every case appeared to be over-ripe. Oysters taken from the bed at the same time and from the same locality, but kept in a basket over night, gave good results.

b. The process of segmentation is hastened by a high temperature and retarded by a low. At Beaufort I experimented with several lots of oysters, or eggs rather, exposing them to different degrees of heat. All the eggs came from the same lot of oysters and were fertilized at the same time. They were exposed to a temperature ranging from 70° to 80°, and quite a marked difference was noted in the rate of segmentation. At the same time a lot of eggs under Dr. Brooks's care made no advance in development for several hours (the night was a cool one) until placed by the fire, when the segmentation began and advanced rapidly. I always noticed the retarding or destructive effects of low temperatures, both at Beaufort and Fair Haven.

c. A very high or very low temperature or violent changes of temperature destroys the egg. In the experiment mentioned above, though the eggs exposed to the high temperature (80°) advanced most rapidly, yet but few reached the swimming stage. I noticed subsequently, at Fair Haven, the same circumstance. High temperature also appears to conduce to irregular segmentation, the egg dividing at once into a number of segments, and the distinction between macromere and micromere not being so apparent as under ordinary circumstances; but I made no special study of this matter and cannot state with certainty that the irregularity is due to the high temperature. In 1879 Dr. Brooks noted the destructive effects of low temperature, and though during the past season I made no experiments having especially in view the settlement of this point, yet as the invariable result of a few hours low temperature was the failure of the experiment in raising the egg, and, as there is but a very slight advance, if any, in the development after the low temperature sets in, I think it safe to conclude that low temperatures tend to stop the progress of the egg. Without intending to establish a fixed standard I am of the opinion that the temperature should be between 65° and 75° Fahrenheit, and that the nearer 70° it is, the more likely is the experiment to be successful. Whatever temperature is started with, the changes afterwards, during the segmentation of the egg or development of the embryo, should be gradual. I noticed that after a change of a few degrees, due to exposure to the rays of the sun, or to a cool shower of rain, or a squall of wind, my experiment usually failed. So far as it is possible to judge in the absence of experiments looking directly to the obtainment of information upon this point, I consider a change to low temperature more disastrous than a change to high. How great a range can be safely permitted it is impossible to say.

The remarks upon the effect of the temperature on the development of the egg hold good, to some extent, with regard to the development of the embryo, though I did not make any experiments upon the latter. The range of temperature permissible with the embryo is probably greater than with the egg. At least I noticed that a sudden fall of temperature which would destroy the eggs did not apparently have any effect upon the swimming embryos, certainly not any immediate one.

Density.—Some years ago Count Pourtales called attention to the fact that oysters did not exist in water of a less density than 1.01—1.00 representing the density of distilled water. My investigations in the Chesapeake lead me to the same conclusion, and I also inferred that a violent change of the density of the water surrounding the oysters would not only affect the mature animals, but would influence the formation of the generative fluids, their development, and the different processes by which they were converted into "spat," in a manner somewhat similar to the effect of changes of temperature. My observations during the past season tend to confirm these latter impressions, but the changes of density and temperature are usually so closely correlated that it is hardly possible to eliminate the influence of either.

As I am not here dealing with the mature animal, except so far as is necessary in considering the artificial production of the young, I shall not revert to the effect upon flavor, growth, shell, characteristics, &c., due to dissimilarity in the constituents of the water; how much or little they influence reproduction, it is, in the absence more exhaustive experiments, at present impossible to say; but the following points are of interest: Shoal-water oysters spawn first, and the less the depth of water the less the density. Also, shoal-water oysters generally lie in the neighborhood of fresh-water streams, or in water of low specific gravity. Deep-water oysters, or those exposed to exactly opposite conditions, not only present exactly opposite characteristics to the shoal-water oysters as regards time of spawning, but they also, so far as my observation extends, contain a much smaller amount of generative matter. So many other conditions obviously operate in effecting the foregoing that it is, however, impossible to decide which influence predominates.

That a change from water of considerable density to that of less very soon has an appreciable effect upon the generative matter appears to be settled; that the effect is a deleterious one is not so clear, but in my own opinion it is. It is well known among oystermen that transplanting during the spawning season puts a stop to the reproductive process; or as they express it in the Chesapeake region, "Plants do not spawn" The transplanting there is from deep and dense water to shoal and brackish, and my own experience at Fair Haven under similar conditions leads me to conclude that the oystermen are correct. The cause appears to be, that in the substitution of warmer water of lower specific gravity, not only is the formation and expulsion of the ova and sperma-

tozoa hastened, but the animal becomes diseased, or at least abnormally replete, from the absorption of an inordinate amount of food or the endosmotic action of the fresh water.

In experimenting at Beaufort I used for the impregnated eggs, while segmenting, ordinary sea water, and in other cases water diluted one third with fresh well-water, and met with sufficient success with the latter to impress me with the peculiarity. In one case I divided the lot of eggs immeditely after impregnation, subjected one half to salt water undiluted and the other half to water diluted one-third, and noticed quite a marked difference in the development of eggs and embryos, those in the brackish water advancing most favorably and living longest; but as I was not able to continue these experiments in a very accurate manner, and as so many other conditions may have influenced the development, it would be rash to decide that a marked reduction of density is necessary to the success of the experiments. On the whole, other things being equal, I should prefer brackish water to pure sea water. It is worthy of note in this connection, that at Fair Haven the experiment failed at an early stage when water from the Sound, which approximates to pure sea water, was used; but as changes of temperature and errors of selection and manipulation were accompanying causes of failure, the influence of the density of the water remains obscure.

As to the influence of the density upon the embryo, I am unable to speak with any authority, owing to the fact that we had swimming embryos under observation for but very short periods, and having in view a particular end to reach, were loth to experiment with those that progressed favorably. Both Dr. Brooks and myself succeeded in raising the embryo to an advanced stage in both salt and brackish water; but we did not experiment with the water after once placing the embryos in it, and consequently I am unable to say what would be the effect of a change of density. The embryos are of so delicate an organization that it seems probable that a change in this or in any particular must affect them disadvantageously.

Currents.—Oysters do not live, obviously cannot live, for any length of time in perfectly quiet water. The currents passing over the beds are necessary to the animals in many ways, but principally in supplying food and in securing the contact of male and female fluids. It is well known among oystermen that there is but a limited reproduction on beds not subjected to the influence of tidal or other currents; and in consideration of that fact I made a few experiments with the intention of ascertaining whether a current had any effect upon reproduction other than the obvious one of securing contact of the generative fluids. I accomplished my end and secured an artificial current, by revolving in the aquarium jar a paddle wheel, composed of oyster shells, but the appliance had no appreciable effect except a deleterious one, and was soon abandoned. Beyond securing more thorough aeration of the water, currents in the aquaria appear to be useless; indeed, the more quiet the embryos were, apparently the more successful was the experiment.

So far as the current acts in keeping the eggs in motion and free from contact, it is beneficial; but this can be accomplished in other ways, and in future experiments I should throw the action of currents out of consideration.

Aeration.—In the early part of the season this was deemed a very important matter, and though our experience failed to confirm the opinion, yet notwithstanding, I am inclined to think that in the future it will be demonstrated that the influence of aeration is considerable, and that it is a necessary factor to success. Certainly the immense numbers of embryos, amounting to many millions in the aquarium jars, cannot, in so confined a space, receive the normal quantity of oxygen, and the fact that constant aeration has been found necessary in all analogous systems of artificial culture makes it probable that it is essential to successful oyster propagation. But, notwithstanding this apparent necessity, my actual experiments, both at Beaufort and Fair Haven, did not appear to be influenced advantageously by artificial aeration, though I gave it a long trial, under various conditions, before abandoning it. Air was forced through the water in large and small bubbles, at the bottom, in the middle, and just below the surface of the water in the jars; the jet was constant at one time, then changed to an intermittent one, and jets were forced over the surface of the water in the jars or shallow dishes; but in no case with any marked advantage. As I have stated in referring to the influence of other conditions, the embryos that were undisturbed advanced most rapidly, and lived longest. As, however, other investigators may wish to experiment in this direction, and as the matter is not conclusively settled in my own mind, I append sketches and descriptions of two forms of air-pump, used by Brooks and myself, which, as the apparatus is easily and cheaply contrived, may be of assistance. In connection with the aeration of the water one point of importance must be noticed, though I have alluded to it already indirectly. The temperature of the air must be, as nearly as possible, that of the water in the jars or plates. This precaution must be observed, even if it is not deemed necessary to the life of the embryo, in order that exact knowledge regarding the effect of aeration may be obtained.

Effect of adding large amounts of lime to the water.—Carbonate of lime is the most important constituent of the shell of an oyster and the probable necessity of increasing the amount available for the formation of the shells of the embryos, early suggested itself to Brooks and myself. Before my arrival at Beaufort Dr. Brooks had made several experiments in supplying inordinate amounts of this constituent with gratifying success; and in the majority of the experiments at Beaufort we attempted to increase the amount by depositing in the bottom of the jars or plates, fragments of the shells of oysters and one of the varieties of echinoidea. The latter is known commonly as the "sand dollar" and being flat, smooth and clean answered the purpose very well.

Dr. Brooks succeeded several times in obtaining embryos in quite an

advanced stage, and generally at Beaufort we noticed that though the development did not proceed much, if any, beyond the stages described and figured by Brooks three years before, yet the rate of development was very much increased, the embryo arriving at the most advanced stage in forty-eight hours, while in 1879 it had required some seven and eight days to reach the same point. Dr. Brooks informs me that his earliest experiments, those prior to my arrival, were the most successful, and that he succeeded in maintaining the embryo alive until they had advanced considerably beyond any stage described by him. The experiments subsequent to my arrival were not so successful, except in the respect noted, viz, the increased rate of development, and this appeared to be due to the addition of the lime to the water. A few experiments in which lime was not used gave rather conflicting results, the embryos reaching the advanced stages in nearly the same time, but in much smaller numbers. I should say that fully one hundred lived in the water containing the shells to one that survived in the other.

The rapid advance was so gratifying, and the addition of lime, which was the only essential change from the previous methods of experimenting, seemed so conclusively its cause, that both Dr. Brooks and myself have been, perhaps, too sanguine of success from the use of the shells and, perhaps, too hasty in assigning to them so much influence. At Fair Haven I was unable to obtain nearly so good results though I used besides the shells quantities of precipitated chalk which should have been more easily decomposed than the shells. I found the embryonic shells in this latter case to require from four to six days to develop, which is not a very material advance over Brooks's results in 1879. Viewing that fact together with the results of the experiments at Beaufort, especially those conducted without the assistance of the lime, I am of the opinion that the influence of that factor is not so great by any means as I had supposed, and that the success we met with in the early part of the season must be assigned to other causes, though the supply of lime may have rendered, and probably did render, some assistance.

Presence of Infusoria.—A short time after placing the swimming embryos in new water, even though all care is used and all precautions observed, infusoria will begin to appear and thenceforward will exercise a more or less deleterious influence upon the success of the experiment. It is impossible to obviate this difficulty though care in selecting the oyster and in manipulating the eggs may do much to diminish the evil. Attention should also be given to the water selected, which, so far as my experience goes, should be recently taken from the sea. If shells are used in the jars or plates, they should be thoroughly cleaned and boiled before using them. But notwithstanding all precautions which may be taken, the entire absence of infusoria cannot be secured. Numbers of embryos will die and decompose, and the infusoria resulting will constantly increase.

Their influence seems to be a most disastrous one. They not only consume the oxygen and such small quantities of food as may exist in the water, but appearances indicated a direct attack upon the ciliated, embryo oysters. We frequently observed numbers of embryos, that had developed in a perfectly normal manner, lying at the bottom of the jars and plates, incapable of movement on account of the absence of cilia, and after continued observation of embryos and infusoria in watch crystals, I feel a reasonable certainty that upon the first indication of impaired vitality on the part of the oyster embryo, it is immediately attacked by the infusoria. Of one thing there is no doubt whatever; the destruction of young and the advent of infusoria are coincident, though which is the cause and which the effect is not so clear. Probably each accelerates the other.

Supply of food.—Considering the immense number of embryos collected in a comparatively small receptacle, in these and similar experiments, it is evident that the maintenance of anything like an adequate supply of food is a very difficult matter. Indeed, it is not yet positively ascertained what the food of the embryo is and until that point is settled it is hardly possible to devise any method of supplying the aquaria. The probability is that the bacteria evolved from the decomposing matter in the waters of creeks, rivers, and littoral area, form the principal article of food, but the difficulty of obtaining and affording a sufficient supply to the millions of embryos in a jar or plate seems insurmountable. Brooks tried to produce the bacteria by decomposing starch and then adding the water to the aquaria, but met with no success, and as little attended the use of ordinary ditch water diluted with that from the sea. By collecting water and mud from an oyster bottom lying remote from the dense waters of the Inlet, and adding small quantities to the water already in the plates, we met with a moderate degree of success; the young oyster, as seen under the microscope in a watch crystal, attracting and securing minute particles of animal or vegetable matter, and digesting them. In quite a number of cases the stomach was gorged with food and the sweep of the cilia, continually brought more within reach of the minute animals. Notwithstanding this success, however, the embryo died eventually without making any material advance, and I account for this destruction by the supposition that we were unable to supply sufficient food, each oyster obtaining but a small amount compared with its necessities and normal supply; and also by the fact that after a day or two the amount of sediment carried in with the water containing the food was sufficient to smother the embryo. Those oysters under observation certainly did thrive very well; their shells were large and well defined, and though we saw none that had actually attached to any "cultch," yet Dr. Brooks discovered numbers of shells, which had not been separated, with one of the valves very much larger than the other. As it is well known that immediately after attachment, the upper valve grows much more

rapidly than the lower or attached one, it is probable that the empty shells noticed by Brooks had been attached until the oyster died, and the survival of the embryo until that stage was reached (point of attachment) must have been due to the supply of food being approximately sufficient, as I did not notice any embryos in a similar state of development except in those experiments in which we attempted to increase the available amount of food. In future experiments in this direction the attempt must be made to supply bacteria unaccompanied by sediment or large quantities of water. Otherwise there will be but a renewal of our experience of the past season.

Time and place of attachment.—The experiments of the past season have thrown some additional light on this subject, and have confirmed my previous impressions gained during the surveys of the oyster beds of the Chesapeake Bay. There is but little doubt in my mind now that the young fry will prefer the lower or more secluded points or surfaces in selecting a place for permanent fixation. I observed in 1879, in the Chesapeake, that the lower sides of the collectors I placed on the beds secured a much larger "set" of young than the upper. As disturbing influences may have prevented the continued life of the young attached to the upper sides, and as those sides were more accessible to the various enemies of the young, I hesitated in deciding that the large number of oysters discovered on the lower sides was due principally to the natural habits of the embryo; but my observations at Beaufort and Fair Haven indicate that such is really the case. It was uniformly noticed, both by Brooks and myself, that the largest number of embryos was always found on the lower side of the shells placed in the jars and plates, and this difference was quite sufficient to be remarkable, even had not our attention been directed to it primarily.

As to the time of attachment, we were unable to obtain any positive evidence, but incidentally I observed certain peculiarities of attachment both at Beaufort and Fair Haven which are significant. Dr. Brooks states that after the eggs have passed through the various stages of segmentation and have developed cilia, the embryos swarm to the surface, remaining there for a limited period and then swimming about through the entire volume of water. Our observations at Beaufort and my own at Fair Haven confirm the truth of Brooks' statement, and it is hardly necessary to allude to it, but that I wish to call attention to the fact, and to the peculiar movements of the embryos during this stage of their existence. While at Fair Haven I had constantly under observation many different lots of embryos in this stage, and the uniformity of their movements attracted my attention. If a large number are collected in a deep beaker and held up to the light they will be seen as a cloud of dust, permeating the whole volume of water. In a few moments a dense film of embryos will be found at the surface of the water; sometimes this is so thick that it becomes opaque when looking through the bottom of the beaker. If the beaker is jarred so as to

make a slight wave motion on the surface, the embryos will be seen descending from that surface in long comet-like streams and these streams invariably tend towards the sides of the glass. The mass of water will present for several minutes a very peculiar, streaked appearance, due to the descent of the embryos. Close observation will discover that after reaching the bottom the embryos rise again through the water (now quiescent) to the surface. If a shell is placed in the bottom of the beaker the tendency of the streams to avoid the edges and pass under the lower side is quite remarkable. Curious whirls and eddies appear to exist, and it is noticeable how closely the embryos follow the lead of the head of the column.

Our observations at Beaufort showed us that after the embryos had once developed the shell to any extent there was but little motion of translation, the animals remaining quietly in one place at the bottom. Indeed their specific gravity at this period, together with their deficient locomotive powers, should prevent any very rapid or extensive movements. Now it has been observed by numbers of persons, indeed every one who has visited oyster regions, that the piles of wharves, the trunks of trees near the water, the abutments of bridges and piers, and many other substances similarly situated, are covered with young oysters and sometimes with old, and that this attachment appears to be greatest between the high and low water marks. Numbers of floating objects have also frequently been covered with the young fry, such as boards, branches of trees, and the bottoms of vessels. Considering the fact that the embryos swarm to the surface immediately upon the development of their swimming powers, that upon any disturbance there they sink or swim towards the bottom, making way diagonally as if in search of some secure place for attachment, that as soon as shells are developed they remain in a comparatively quiescent state at the bottom, and that when it is possible large numbers attach about the surface of the water, I have come to the conclusion that the oyster embryo is predisposed at least to fix itself very soon after the process of segmentation is completed; that as soon as cilia are developed they serve a double purpose, not only affording a means of translation, but also one of fixation. This is a hypothesis, of course, and the postulates upon which it is based are only in a measure sound; but judging by the evident disposition of the embryo with shell to remain at the bottom and nearly in one place, I can account for the attachment at the surface of the water only by assuming that it occurs at some period anterior to the development of the shell. It is not very difficult to understand how the embryos in swarms at the surface may be disturbed by a slight commotion of the waters, and streaming off obliquely to the bottom, may come in contact, and be entangled by the cilia with any of the various objects it is so frequently found attached to; and failing to find such, it will continue its search until it reaches the bottom and then bury itself under or about shells or other exposed "cultch." Failing to attach there, it will rise again to the surface and repeat the process

until, the shell having formed and each succeeding ascent being less, the embryo will be unable to overcome its own weight and will remain at the bottom, attached and sure of life if the object be suitable, or unattached and thus certain of a speedy demise. If I am correct in this view, its importance is considerable, especially so to private oyster-culturists. It is evident that if attachment may occur at any time during the free swimming stage, "cultch" or collectors may be exposed, indeed should be, not only at the bottom, but serierally to the surface. The indications are that floating brush collectors, exposed as closely as convenient without offering too great an obstacle to currents and navigation, would give good results, and I regret that I was unable to make an experiment with them during the past summer. If my view is correct, the oyster planters of Long Island Sound and Narragansett Bay lose annually a large number of oysters by neglecting floating collectors. Many of them have tried one or two forms and have met with varying degrees of success or failure, but I do not know of any instance where the failure was due to inherent causes, but rather to defective apparatus or methods. I do not wish to be understood as advocating brush collectors, as they may in certain localities be unsuitable; but I strongly advise floating collectors both for experiment and practical work.

Though my experiments during the past season have not been productive of any positive results, I do not feel by any means discouraged as to the eventual solution of the problem. It still seems possible to artificially produce and raise an oyster, and in course of time I have no doubt that the object I had in view will be achieved either by myself or others. It may be attained by some happy, accidental discovery, or by a patient investigation of all the conditions affecting and favoring the life of the embryo oyster. Perhaps I and others have spent too much time in attempting to reach the desired end at a single leap. It is my own opinion that we have, and that the final result will only be obtained after a careful and pains-taking series of experiments, which will begin as nearly as possible, with the most important influence and determine its extent before attempting to proceed further. In other words I would recommend for the future that experimental work follow a strictly scientific course; that there be a massing of facts and a careful digestion of them; that the hypothesis based upon such digestion be carefully followed out to its legitimate conclusion, and if ending adversely a review of the ground be undertaken. The conditions affecting in more or less degree the life of the oyster and embryo are fairly well known, and in studying the extent of the influence of these various conditions will be found the road which will lead to the attainment of the main object.

I have left until the last the mention of my experiment in placing embryo oysters on the beds, not because it was not of some importance, but because it was an incidental part of the work I had undertaken. After the experience acquired at Beaufort, and after observing the dis-

position of the embryo, with shell, to remain quietly at the bottom, I came to the conclusion that if the artificially-impregnated eggs could be protected during segmentation, and the resulting embryos maintained alive until the shells were well developed, they might be deposited on the beds with a fair chance of a large number, probably a majority, surviving. To keep the embryos alive until they reached such a stage was not a matter of much difficulty, nor was the deposition on any chosen point of a bed an operation that could not be easily performed. The only question was whether any decisive result would be obtained, or rather whether it would be possible to ascertain positively that the embryos had survived. Considering that there might be a large natural attachment on a bed and that the artificially-raised embryos might be dispersed over a somewhat large area, it appeared very doubtful if any results would be produced upon an inspection of the beds. I thought the chance however, of a successful issue sufficiently good to justify my trying the experiment, and accordingly while at Fair Haven I fertilized as many eggs as possible and deposited the embryos, in various stages of development, on one of the beds owned by H. C. Rowe & Co., of Fair Haven. That the experiment should attain an obvious success evidently depended upon the deposition of a very large number of eggs and it was my endeavor to furnish as many as possible for the purpose; but owing to accidents of weather and apparatus I did not succeed in placing on the bed as many embryo oysters as I wished or had hoped to do. I soon found that in working on so large a scale I lost a proportionately larger number of oysters than when fertilizing the eggs of a few females for experiments in aquaria; but I succeeded in placing at one point some ninety million embryos, of which fully one-half were well advanced in development. They were carried out to the buoy marking the spot, by one of Mr. Rowe's steamers and then lowered in a double-headed can to the bottom; the covers of both ends of the can were then removed and the young fry allowed to wash out. As they were practically on the bottom I hoped they would at once find points for attachmont among the recently spread shells, and that an inspection of the bed in the autumn would show that the attachment at this point was sufficiently great, and above that on other contiguous portions, to justify the assumption that the superiority was due to the attachment of the artificially-raised embryos. Naturally, in order to afford conclusive evidence, the superiority would have to be very great; but even should such not be the case it by no means proves that a majority of the embryos did not attach, as they might have been widely dispersed by some unforeseen cause or accident. If any evidence at all is given, it must be of a favorable nature. The absence of evidence proves the experiment, but not the theory to be at fault.*

*Since writing the above the author has received the results of the examination made by Mr. Rowe, which are summarized as follows: The attachment of spat was general over the whole bed. It was noticeably larger at the point where the artificially-raised embryos were deposited, and was also larger along a line extending N.

In conclusion I have to express my indebtedness to Dr. Brooks for the assistance afforded me at Beaufort, not only in conducting the experiments, but in permitting me to use the steam-launch and employés attached to the Johns Hopkins Laboratory. I am also under great obligations to Mr. H. C. Rowe, of Fair Haven, Conn., who allowed the use of his office and part of his packing-house as a temporary laboratory, supplied me with all the oysters I used, and put his steamers at my service whenever I desired to employ them. I am also indebted to him for making my stay at Fair Haven as agreeable as possible, and giving me all the information in his power regarding the Connecticut oyster fisheries.

EXPLANATION OF THE PLATE.

Fig. 1. *Method of arranging plates so as to separate swimming embryos from dead eggs.*—B is the lower dish, containing oyster shells or carbonate of lime. A is the plate holding eggs in process of segmentation. Plate A is slightly inclined and nearly full of water. When the embryos begin to swim, a minute supply of water is added to A from the jar C, by means of a siphon, D. The supply is so arranged that the drops strike the edge of the plate A, so as to prevent any disturbance of the eggs in the bottom of the plate. Water from A will overflow into B drop by drop, carrying the swimming embryos with it. A piece of paper or card-board (x) should be placed so as to prevent any considerable fall from A to B.

Fig. 2. *Method with funnel.*—The figure explains itself sufficiently, B representing the funnel and A the jar which is to contain the embryos. The only point of importance is the necessity of giving the funnel B a slight inclination so that the overflow may be more constant and in one place.

Fig. 3.—B shows the character of funnel used during the past season, x being the cork with perforation for glass tube z, through which the jet of air or water was forced. The disadvantage of the arrangement consisted in the form of the funnel. The eggs collected in a thick layer on and around the cork, as shown by the shaded parts in the figure; in the middle, the jet kept the majority in suspension. The improved cone or funnel shown in Fig. 4 would, I think, obviate to a great extent this evil, the interior of the funnel being perfectly conical and the tube of rubber conveying the air or water fitting over the apex of the exterior. The channel yz should be very small, as only a minute jet of either air or water is necessary or desirable.

Fig. 5 shows an air pump devised by Brooks, which is a convenient arrangement for the use of laboratories situated where there is no great head of water attainable. B is a tube, with funnel at the top (c) in-

W. and S. E. from that point. (The usual set of the tide is in that direction.) While the foregoing are favorable indications, they are not considered sufficiently strong to justify an assertion that the experiment was entirely successful. Other attempts may settle the question.

serted in a jar or tank, A, which is hermetically closed. The end of the tube B should pass through the cover *g g*. E is the overflow pipe, fitted with a sliding extension, D, so that the overflow may take place at any desired height. F is the air pipe; C, the stream of water entering the funnel from a small vessel. The apparatus requires but very little water and little or no head to supply all the aeration necessary for laboratory purposes. The water running from the receptacle H, through the nozzle C, is made to impinge against the sides of the funnel so as to give a rotary motion. A small glass ball or vial partially closes the upper end of the tube B, and the column of water in the tube is thus a broken one, the intermediate spaces being filled with the air carried in by the suction. As the tank A fills with water the air is forced out of F. The overflow of superfluous water is regulated for different depths, or rather for different pressures on the end of F, by raising or lowering the movable arm D. The power of the pump is of course proportional to the length of the tube B. Four feet fall of water furnishes a sufficient supply for most laboratory purposes.

A second simple pump is shown in Fig. 6. A A are two casks having stop-cocks at *m*, *n*, *o*, *p*, *s*, *t*. The cocks *s* and *t* are connected by rubber hose; from *m* and *n* hose runs to a point, *k*, whence the main air-supplying hose is led to the aquaria. Both casks are fitted with slings and tackles for raising and lowering them, and the pump is worked in the following manner: The cask *a* being filled with water, the cocks *s* and *m* are closed and the cock *o* opened; the cask is then raised six or eight feet. The cock *p* of cask A′ is closed and cocks *n* and *t* opened. Then, by opening cock *s*, the water flows from *s* through *t* into A′, forces air out of *n* to *k*, and thence to the aquaria. When the upper cask is empty, it is lowered and the other one raised, and the process reversed. A 40-gallon cask will supply air for eight to ten hours, and with a small luff-tackle can be raised easily by two persons.

I have made these sketches and accompanied them with the descriptions not because of any great merit or originality the apparatus possess, but because others may find their use of benefit and be saved some trouble in experimenting with methods and appliances having the same end in view.

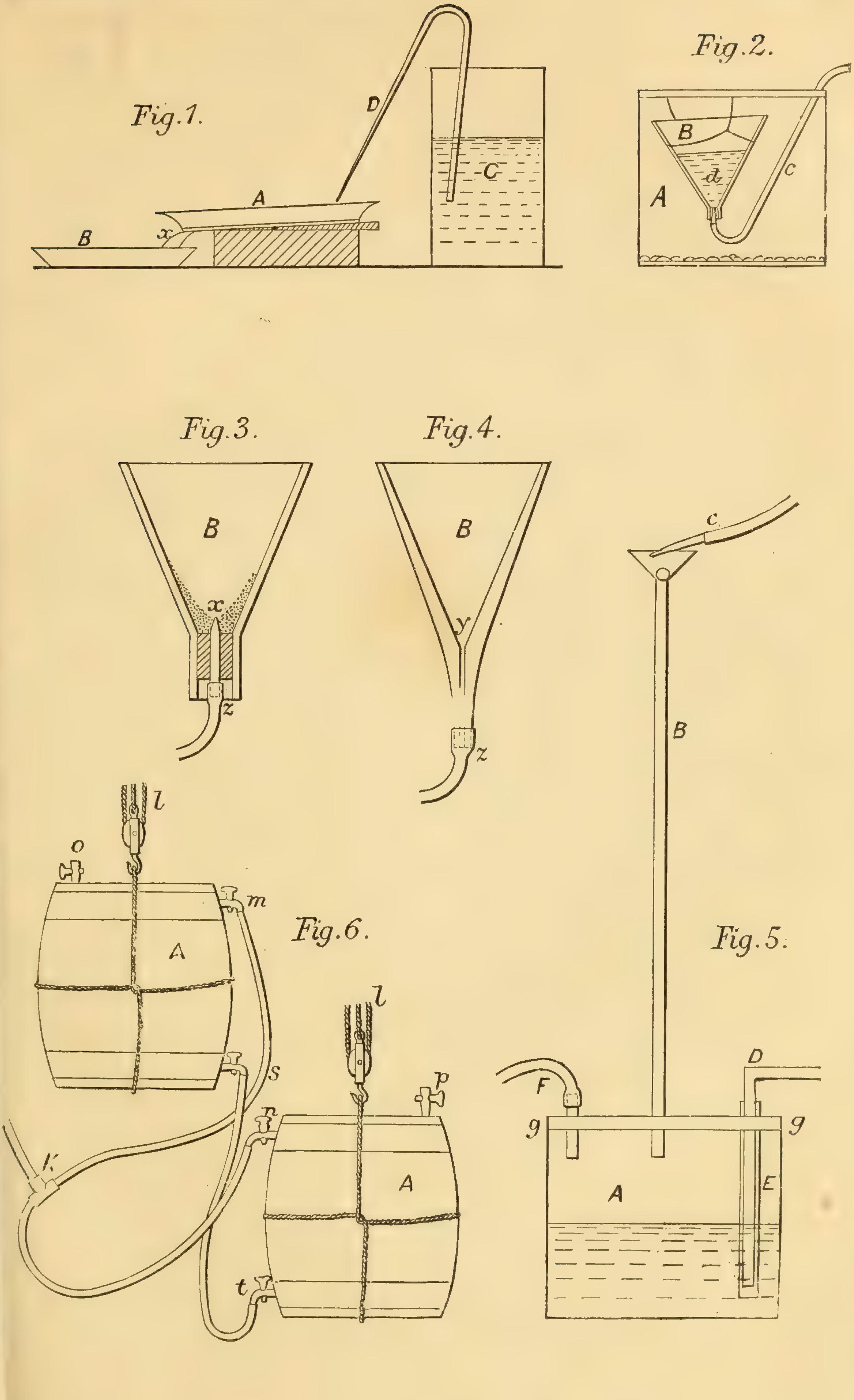
Fig. 1.
Fig. 2.
Fig. 3.
Fig. 4.
Fig. 5.
Fig. 6.

XXIV.—AN ACCOUNT OF EXPERIMENTS IN OYSTER CULTURE AND OBSERVATIONS RELATING THERETO. (SECOND SERIES.)*

By John A. Ryder.

The work of experiment with the eggs and embryos of *Ostrea virginica* were carried on for the season of 1882 at the experimental station on Saint Jerome's Creek, Maryland, by Col. M. McDonald and myself, under the auspices of the United States Fish Commission. Other experiments were also conducted at Beaufort, N. C., by Francis Winslow, U. S. N., and Prof. W. K. Brooks, while Mr. Henry J. Rice experimented in Mr. E. G. Blackford's laboratory, Fulton Market, New York City. The other observers named above will, however, probably publish their results at length in due time, so that it is unnecessary for me to do more than allude to their work.

I left Washington with the United States Fish Commission steamer Fish Hawk in June last, but did not begin any actual investigations until July 3 following. In the description of my investigations, as well as those made jointly with Col. M. McDonald, I shall rely in great measure upon the journal in which I recorded the principal observations and experiments from July 3 to August 11, 1882.

July 3.—Investigated the contents of the stomachs of a number of adult oysters taken from the channel which leads to the pond. The following organisms were observed amongst the more or less disintegrated "chyme" examined: Nauplii of crustaceans, their chitinous tests with the soft animal contents more or less completely digested out; empty diatom frustules, as well as a number filled with a vacuolated rich-brown endochorme; one shell of a larval gastropod (*Crepidula*), and some very young larvæ of nudibranchiates; the shell of a larval lamellibranch, not identified, with the valves still adhering together. Mature zoöids of *Pedicellina americana* Leidy were also noticed, and in the posterior portion or pyloric end of the stomach vast numbers of vibrios were noticed, which I identify as a form generically identical with *Spir-*

* The first of this series has already been published in the report of the Maryland Commissioner for 1881, embracing my work for that year. The present paper was prepared some time in September, 1882.

*illum.** The filaments are capable of straightening out and contorting themselves into a great variety of forms. The usual shape of these organisms is that of an apparently spiral thread of extreme tenuity, which exhibits lively movements of progression in right lines, like the *Oscillatoriæ*, *Diatoms*, and lower *Algæ* in general. In consequence of the power which the filaments have of bending themselves, they may also exhibit vermicular movements. This organism is sometimes found in prodigious numbers in the vicinity of the crystalline style. Sewage is not the source of it, because this *Spirillum* [*Trypanosoma*] is found equally abundant in the stomachs of oysters from muddy or from clean bottoms, from deep or shallow water, and far from any possible source of sewage contamination. I also found the tests of a Difflugian in another instance, with the sarcode digested out; the species appears to be *Difflugia acuminata* Shr.† The cephalula stage of development of some worm, species not identified, a mass of vivid green algous cells, stellate hairs from the leaves of a neighboring exogenous tree, filamentous algæ and desmids, completes the list of organisms and organic remains encountered in the gastric contents of the oyster when examined microscopically. Many more might doubtless have been found, had one taken the trouble to spend time in the search.

To-day, at 2.50 p. m., I fertilized a lot of oyster ova; examined about fifty adults in full spawning condition; but in consequence of the fact that the water-supply fixtures were not yet in working order, I gave up experimenting for the present.

The interim from the 3d to the 10th of July was employed in getting our equipment into shape for the work.

July 10.—Impregnated a lot of eggs of the oyster at 3 p. m. to-day; not a very good lot. Had some difficulty in finding a ripe male; but the second lot fertilized at 3.30 p. m. came out much better and began to segment normally within an hour after the time of impregnation.

July 11.—Best lot of yesterday at 3.30 p. m. had the velum distinctly developed to-day, with the shell-gland formed or forming. Tempera-

[* I leave my original description of this organism as I wrote it in 1882. M. A. Certes, in his "*Note sur les parasites et les commensaux de l'huitre*," Bull. de la Soc. Zoologique de France, 1882, describes and figures what is evidently the same organism under the name of *Trypanosoma Balbianii*, and shows that, instead of being spiral as I have described, it is really provided with an extremely thin spiral frill wound around the very slender fusiform body, the frill being the locomotive apparatus of the organism. It measures about $\frac{1}{450}$th of an inch in length. From M. Certes' description, which I have since verified, it is evident that I am in error in regarding it as a *Spirillum*, and that it is, consequently, probably not to be considered as belonging to the group of *Schizomycetes* at all. (January 3, 1884.)]

[† This may have been the test of a species of *Tintinnus*, a peritrichous infusorian, some of the species of which build a chitinous case covered with grains of sand very like the tests of *Difflugia acuminata*. For further facts regarding *Tintinnus* as food for the oyster, see my paper entitled "Rearing oysters from artificially fertilized eggs, together with notes on pond culture." Bull. U. S. Fish Commission, III, 1883, p. 293. (January 4, 1884.)]

ture of water ranged to-day from 87° to 78° Fahr. The apparatus for blowing air upon the surface of the water in the glass hatching-dishes was applied to-day; it seemed to help to keep the water aerated and cooler by 3 or 4 degrees than in a vessel over which the air was not blown. Added a little, not over a tablespoonful, of a saturated calcic hydrate solution [lime-water] to the water in which the embryos were developing at 3.30 p. m. This was probably soon after converted into calcic carbonate by combination with the free carbonic dioxide in solution in the water.

I fertilized a fine series of eggs to-day at 12 m. and 12.20 p. m., which were developing finely at 3.30 p. m. Added a little lime-water or calcic hydrate to the water in which these last were developing, as soon as they were placed in the hatching-house.

In order to test the possibility of changing the water on the eggs, I devised a simple filtering apparatus, constructed as follows: Over one end of a straight-glass argand lamp-chimney I secured a diaphragm of filtering paper between single thicknesses of light muslin or cheese-cloth, the whole held to the chimney by a stout rubber band, which bound down the free overlapping edges of the cloth and paper to the chimney all around. This apparatus was found to answer to a certain extent, but, like all the filters hitherto tried, was found to clog up and finally become impervious. The chimneys were suspended with a peculiarly arranged wire ring, which it is unnecessary to describe, depending for about two-thirds of their length into shallow glass bottles with wide necks. The fresh water was poured into the upper open ends of the chimneys from time to time by hand, and allowed to percolate through the diaphragm below into the bottle, overflow from the latter around the chimneys, and run off. This arrangement would work for a while only; the diaphragm would finally clog altogether, and, if the number of embryos in one of the chimneys or cylinders was too great, putrescence was soon established, when our experiments would come to an end. It was also found that the chimneys were too deep; their great depth, as compared with their width, would force the eggs to settle on the small area on the diaphragm at the bottom, tending to suffocate the ova, arrest their development, and kill them. In order to change the water, I then resorted to common glass funnels and filtering paper, with indifferent success.

I to-day examined some of the oysters one year and eleven months old, which had caught on the collectors put into the creek in August and September, 1880, by my party, under the auspices of the Maryland Commissioner. The largest specimen measured $3\frac{3}{4}$ inches in length and $2\frac{7}{8}$ inches in width. Another smaller specimen was found to measure 2 inches in width and $2\frac{1}{4}$ inches and a quarter in length. These specimens were found to have the reproductive organs developed and contained ripe spawn. This showed how rapidly oysters which were started from the egg would develop in the course of twenty-three months.

July 12.—Eggs of the 10th, at 9 a. m. to-day, so diminished in numbers as to be hard to find. Those still alive have velum developed and are swimming about actively. Infusoria are developing rapidly and in large numbers; of these there were large numbers of holotrichous species, besides very small monads, which were by far the most numerous. I have about concluded that we put entirely too many eggs into a given volume of water, thus increasing the chances of putrefaction. I do not see, however, that the protozoa are destructive; none that I have seen appear to be capable of destroying an oyster embryo. Some vibrios which have made their appearance indicate a more alarming condition of affairs. Eggs of the 10th were practically dead to-day, though a few embryos might still be found after much searching.

Eggs of the 11th were not as completely freed from milt as they should have been. The water in the hatching-dishes is putrescent this morning, with teeming hosts of putrefactive organisms. Zoöglœar membranes or pellicles are visible on some of the dishes. Heat has been greater to-day than yesterday; last night was cooler than previous one. Thermometer 85° in the air at 9 a. m.; water in the dishes 84° at the same hour. Quite a number of embryos are still alive however; the last lot more developed than the first at the same relative age. Many with the shell-gland developing. Some were also seen to disintegrate while under observation. Some had a slimy filament attached to them which impeded their progress in swimming. These phenomena may explain Davaine's statement regarding the detachment of the velum; in other words what he saw was probably simply a putrefactive process involving the incipient disorganization of the embryos.

At 2 p. m. I transferred the embryos of the 11th into a 2-gallon glass aquarium, and then filtered off most of the water through a cotton-wool filter, which seemed to work pretty well, separating the most of the eggs from the water which runs through quite rapidly. The putrescent odor after this operation was not now so apparent.

The cotton-wool filter was constructed precisely as the one in which filtering paper was used, only instead of the latter I used a thick pad of raw cotton saturated with water, varying from one-fourth to three-eighths of an inch in thickness. This contrivance, for the construction of which I had received my first hint from the experiments of Pasteur and Tyndall, allows the water to pass through rapidly, but is very effective for a long time, as it clogs very slowly. I have great hopes of the performances of this last form of filter.

Meanwhile the putrescent action in the aquarium has apparently exhausted itself. I have had the air-blast blowing on the surface of the water, and have also immersed one blast-nozzle so as to cause the air to bubble up through the water in the aquarium.

July 13.—Putrescence has been to some extent impeded by the air-blast, eggs of the 10th July swimming about at a lively rate and in the condition of Brooks's Fig. 38. There are, however, but very few sur-

vivors now remaining, and if one is careful to examine the *débris* and sediment at the bottom of the aquarium a few dead shells of embryos may be detected with all of the soft parts gone. The most important step in advance to-day has been a thorough test of the cotton-wool filters, which will hold the eggs, but which will lodge in the meshes of the filter, which is a serious drawback. This requires that after using one of the filters for a short time, in order to change the water on oyster embryos, its action must be reversed; that is to say, one must let fresh water pass through the contrary way in order to wash out those embryos which have lodged in the meshes of the cotton wool.

In consequence of the air-blast blowing continually over the surface of the water in the hatching-dishes, there has been considerable evaporation going on, so as to raise the specific gravity of the water in the dishes considerably. This does not seem to affect the health of the oyster larvæ which are still alive.

I fertilized a lot of ova to-day, with very unsatisfactory results; the impregnation was not at all successful. Ten adult oysters were used in the operation—3 males and 7 females. The males were plentier than on previous days. Temperature of the water to-day ranged from 80° F. to 85° F.

June 14.—Cotton-wool filter impracticable for use with a continuous flow of water, but may be useful in the course of other experiments for the renewal of the water on eggs and embryos. This was fully tested by using a series of McDonald jars, connected together with rubber hose somewhat like a series of Wolff's bottles. The exit-pipe of each jar was filled with a cotton-wool filter, so that the water in the third and last jar had undergone three distinct filtrations, the result of which was that the water had become exceedingly clear and free from foreign particles, in fact had been more effectually cleansed than by the use of any other filter I ever had seen tried. Theoretically this apparatus, through which the water ran in a stream about as thick as a crow's quill, ought to have retained the eggs and embryos of the oyster, even though these were only one five-hundredth of an inch in diameter. The result of an experimental test showed that such was the fact; that the eggs and embryos would be retained, but that they would lodge in the meshes of the filters, where they would finally be covered by other sedimentary organic and inorganic matter. The result of this experiment showed us clearly that this method of incubation would have to be abandoned for something which would meet and satisfy the conditions of our problem more completely. A poor lot of ova were used in testing this apparatus, and after its unfavorable performance was made apparent, it was not thought advisable to waste any more eggs in its use. The prevailing temperature of the water to-day was from 82° F. to 87° F.

The embryos of previous lots which had been incubating in glass dishes and aquaria had not been amounting to anything up to this time; they were therefore abandoned after a few had reached the age of from

four to five days and then died. Many, in fact the majority, of the survivors were more or less diseased, showing vesicular protuberances from the surface of the body and slow and abnormal movements of the cilia, with a tendency to develop and trail a slimy thread-like appendage after them to which various foreign bodies would adhere and impede the free movements of the infantile oysters. This slimy thread I regarded as a product of retrogressive development, perhaps, indeed, of incipient putrefactive or disorganizing changes. The 15th and 16th days of July were employed in following up the development of the lots of eggs which had been fertilized before those dates.

July 17.—Another lot of eggs were impregnated this day at 10.30 a. m., an entirely new method being employed in the operation. The eggs and spermatozoa were in fact squeezed from the animals with the end of a smooth, slightly curved pipette; the latter, which was provided with a collapsible rubber bulb at top, was also used to lift up the generative products and transfer them to the dishes in which they were fertilized. The pressure of the side of the pipette was applied progressively along the oviducts, which open and pour out their contents uniformly at one point on either side of the body. In this way I find that I get quite as many eggs as by chopping up the visceral mass, and without contaminating the emulsion of eggs and spermatozoa with fragments of the other tissues of the body. Temperature of the water to-day fell from 84° F. to 76° F.

My success in taking the eggs and spermatozoa by pressure upon the generative organs and ducts led me to think of applying a similar method of investigation to the removal of the contents of the stomach. A short pipette or medicine dropper with a collapsible bulb compressible between the thumb and forefinger was used. The nozzle of the pipette was inserted into the mouth and through the gullet into the stomach, when the contents of the latter may be drawn into the pipette by relaxing the pressure of the thumb and finger upon the bulb. If carefully done no extraneous matters will be taken into the pipette; absolutely nothing except the contents of the stomach will be removed in the operation just described. In a lot examined this morning, I find grains of pine pollen from the neighboring trees, empty frustules of diatoms of various species, and a considerable number of large, brown, boat-shaped ones with the brown endochrome still in them. Many of these were still alive and exhibited their singular and characteristic movement in right lines. A great amount of organic slime and *débris* of organisms was also noticed, but these fragments of the soft parts of organic bodies in most cases were not in a sufficiently good state of preservation to enable one to identify them. As a whole, the slimy contents of the stomach were greenish, the color being due to at least two causes—the color of the biliary secretion, and the microscopic particles of food.

The sexes of the oyster may be readily made out by the peculiar characters of diffusibility proper to each kind of product when dropped

into the water. I find that the masses of eggs when squeezed from the oviducts and dropped into clear water immediately dissociate and diffuse themselves as a uniformly granular cloud if the eggs are perfectly ripe. If the eggs are not perfectly ripe, they do not separate so readily, but tend to adhere together in masses. This accordingly becomes a most excellent test to determine the degree of maturity of the ova; a very important practical point in the artificial method of culture yet to be developed.

The milt or semen of the oyster is stringy and flocculent when dropped into clear water. If stirred the masses break up into wisps and stringy clouds before mixing intimately with the water. When the admixture is complete the water charged with milt assumes an opalescent or bluish-white tint. In practice it is found best to use a very dilute mixture of water and milt for purposes of artificial fertilization, the philosophy of which is this: One spermatic particle only is needed to fertilize an embryo; the spermatozoa are vastly—a thousand fold—more numerous than the ova. A superabundance of spermatozoa used in the process of fertilization simply causes the eggs to be covered with them. The ineffectual ones on the outside of the egg eventually die and putrefy and needlessly pollute the water in which the eggs undergo their development.

The lot of oyster ova impregnated at 10.30 a. m. to-day are already swimming, and have reached the stage at which the micromeres have included the macromeres. The development attained so for has required five hours.

July 18.—Temperature of water to-day ranged from 75° F. to 84° F. Another lot of eggs were impregnated this morning. Embryos of the 17th not doing so well at 3 p. m. to-day. Was probably not careful enough to get rid of superfluous milt. Filters still hold the embryos, but many of them have threads of slimy matter hanging to them, with blister-like protuberances, which are abnormal, due probably to imperfect renovation, aeration and purification of the water, and accumulation of slimy sediment in the jars and aquaria. I fertilized another large lot at 12 m. to-day, using nineteen adults in the operation.

July 19.—Oyster embryos of 17th and 18th diminishing in numbers rapidly. Amœbæ and Infusoria are beginning to make their appearance in the aquaria. The mortality of the embryos is surprising, and as yet I see no sure way which promises much to prevent it; the embryonic shells have been forming, and there is every reason to believe that, could we prevent the initial putrescence and mortality, we could carry them along much further than has yet been done. The temperature of the water has varied from 76° F. to 85° F. to-day.

July 20.—The embryos are hard to find this morning in the jars containing the lots of July 17 and 18, although the men employed in filtering off the water and renewing it have worked most conscientiously both night and day. *Amœba proteus* I find to be abundant in the sedi-

ment, besides numerous hypotrichous infusorians. These are not chargeable with killing the embryos, but probably appropriate their dead bodies after they have fallen to the bottom and begun to disintegrate. Temperature of water ranged from 84° F. to 86° to-day.

July 22.—The remarkable set of experiments in the incubation of the ova of the oyster instituted to-day by Colonel McDonald led to a new series of experimental results as singular as they are contradictory. The above-named gentleman with characteristic ingenuity arranged a series of his hatching-jars so as to form what he called a *closed circuit.* The first element of the apparatus was a cylindrical glass aquarium, about 14 inches in height, placed about 4 feet above the level of the floor of the hatching-house. This was connected by means of a siphon tube of rubber to one of his glass hatching-jars, such as are used in hatching shad ova; a glass tube passing through the cork formed the inlet connection, and a similar tube reaching nearly to the bottom of the jar was joined to a rubber tube outside to form the outlet. Then followed a second jar connected to the first, with similar pipe connections, except that it discharged into a glass aquarium set at a still lower level, the bottom of which was covered with pebbles, to which some living seaweeds were attached and in growing condition. The water then passed through a rubber siphon tube from this second aquarium to two more closed hatching-jars placed at a lower level and arranged just as the first pair; the discharge-pipe of the last jar then carried the water into an aquarium, which rested on the floor. In order to maintain a circulation in this apparatus it was necessary to keep dipping up the water very carefully, so as not to injure the embryos, from the aquarium resting on the floor into the one standing 4 feet above that level. In order to supply lime to the embryos the two pairs of closed hatching-jars had been about one-third filled with clean sun-bleached oyster shells, and the purpose to be served by the living *Laminariæ* placed in the middle aquarium was to supply oxygen to the embryos and absorb the carbonic dioxide thrown off by these and other organisms in the jars and aquaria. The water with which the apparatus was charged was carefully filtered through a cotton-wool filter so as to free it from sediment and objectionable organic matter. After the apparatus was filled no attempt was made to change the water, as it was soon discovered that the water would remain perfectly sweet without renewal. Theoretically, this contrivance appeared to satisfy all the conditions of the problem which had been placed before us for solution.

A lot of eggs were placed in this contrivance at 11 a. m. I was particular to get as fine a lot of ova as possible, so as to test the matter fairly. In order to do this the eggs were expressed from the adults by the new method already alluded to, and fertilized so successfully that I am convinced fully ninety per centum were developing normally when put into the apparatus. My delight and astonishment the next morning at finding that many of the embryos had apparently attached them-

selves to the sides of the jars and the surface of the oyster shells were great indeed. The valves to our surprise were found remarkably well developed and had already grown so as to cover the sides of the embryos, and from between the edges of the valves the velum could be seen to protrude and be retracted at intervals. In fact within the short space of twenty hours we had embryos farther advanced in development than any figured by Professor Brooks in his admirable work on the development of the oyster, published in 1880.

The oyster shells in the jars in the McDonald apparatus may have helped to supply the necessary carbonate of lime for the rapid growth of the valves of the larval oysters. It will be desirable to put this matter to the test. The mode of fixation is still problematical. I even doubt whether the objects which I see fixed to the inner surface of the jars and aquaria by the help of a good triplet are oysters at all; keep vacillating between one and the other opinion all day, because of the imperfect means at my disposal to determine their true nature with certainty. Unfortunately I had not thought of putting small transparent slips of mica or glass in the aquaria in order to afford surfaces for fixation, which could be transferred to the stage of the microscope, without injury to the minute and delicate embryos. The temperature of the water in the apparatus has ranged to-day from 73° to 80° Fahr.

July 23.—The young oysters detected for the first time fixed to the sides of the jars this morning must be examined by such means as will certainly establish their true nature. In order to accomplish this I had our carpenter, Mr. Tolbert, make me a stand of wood to hold the draw-tube objectives and eye-pieces of my microscope in a horizontal position so as to view the embryos in their natural relations on the inside of the glass vessels undisturbed. I find at last, by this means, that the little objects fast to the inner surface of the glass are truly oysters. The pouring and lifting of the water from the lowermost to the uppermost aquarium does not seem to interfere with the attachments of the embryos or their development. Their mode of attachment is still a puzzle. I cannot clearly discern even with a magnification of 150 times—the highest I can use under the circumstances—how the attachment is made.* The positions of the individuals vary; some adhere by the side to the glass and display only a profile view of themselves; others are apparently swayed more or less by the current of water flowing

[*This point I have since settled approximately in my paper entitled, "On the mode of fixation of the fry of the oyster," Bull. United States Fish Commission, II, 1882, pp. 383–387. Unfortunately the figures are reversed in the plate which accompanies that paper through, an unintentional oversight. Figs. 3, 4, 5, 6, and 7 viewed from above should have the tips of the umbos directed towards the left instead of to the right. Fig. 8, viewed from below, should have the beak or umbo of the larval shell directed to the top of the page instead of to the bottom for a like reason. The direction of the umbos or beaks of the larval valves of young oysters is invariably the same, or to the left as viewed from above. The larval valves as well as those of the spat stage are also glued to the surface of attachment, so that the existence of a byssus seems doubtful. (January 4, 1884.)]

through the jar. Some are visible with the edges turned towards the observer and open and close their valves at intervals. Even the ciliary action and protrusion and retraction of the velum is often apparent. The attempt to discover a byssal attachment was fruitless. I usually found such an amount of sediment and slimy matter in the vicinity of the embryos as to prevent me from making out anything of a definite and positive character in regard to this point. The water still remains pure however; no signs of any putrescent action are yet apparent. The cotton filter has been of great use to us. In order to discover whether the attachment of the embryos was accidental or weak, Colonel McDonald detached one of the jars from the circuit and caused a continuous current of water to flow through it. This showed that the attachment was pretty firm; the current so established through the jar did not detach the embryos, as we could see by examining the inner surface of the glass jar with our microscope extemporized for that purpose. The temperature of the water to-day has ranged from 74° to 88° Fahr.

July 24.—Colonel McDonald has arranged a second set of jars and aquaria similar to the first, with the exception that the oyster shells have been purposely omitted in order to learn whether their presence tends to favor the formation of the valves of the young embryos. At 4 p. m. to-day another lot were placed in the second McDonald apparatus. At 4 p. m. the next day shells begin to be developed, but are not so far advanced in this respect as the first lot in the first closed circuit apparatus, and it must also be borne in mind that the temperature of the water is now rising. Temperature of the water to-day has ranged from 79° to 88° Fahr.

July 25.—The lot of embryos which were fertilized on the 22d are still developing finely, and we find that the continuous current of water passing through the jars taken from the closed circuit yesterday does not detach the affixed fry, as revealed by microscopic examination. Allowing a stream of water to pour over the shells to which the fry has attached itself, does not detach the latter, nor does a lively movement through the water of shells, to the surface of which fry has attached itself, produce any detachment of the latter. The entire animal is now covered by the valves; the velum is, however, still protruded. The protrusion and retraction of the velum is evidently effected by the relaxation and contraction of the minute pallial muscles of the embryo. The fixation of the first lot of the 22d must have taken place about twenty hours after the ova were fertilized and began to develop. Strangely enough the embryos fertilized yesterday at 4 p. m. as yet show no signs of having attached themselves to the inside of the jars and aquaria comprising apparatus No. 2. The temperature of the water in the apparatus to-day ranged from 80° to 84° Fahr.

In order to study the fry which was put into the McDonald apparatus No. 1 on the 22d more narrowly, we removed some of the shells from the bottom of one of the hatching jars and scraped the surface with a sharp scalpel. Examining the sediment removed in this way, under high powers of the microscope, we very readily discovered some

of the fry which had been attached to the surface of the shells. We could not discover that it had increased perceptibly beyond the original volume of the egg but could readily make out the course of the intestine, the liver, and stomach, in the cavity of which we could perceive the particles of food which had been swallowed in active rotary movement, impelled to rotate within the alimentary cavity by the numerous vibrating cils or filaments with which its inner surface is clothed. The presence of a body cavity was very evident, but no evidence of a pulsatile movement or the presence of a heart was evident. The hinge border of the valves of these embryos was truncate and linear, as in the valves of the embryos of the European oyster. No evidence of an umbonal prominence with a spiral tendency was apparent, such as may be perceived in the valves of the larval shell when it is over four times as large across, or of the size when it is suddenly converted into that of the spat, as I have described elsewhere.

July 26.—I fertilized a very fine lot of eggs to-day at 10 a. m., which began to swim about at 2.30 p. m. These were placed in apparatus No. 1, in which the old oyster shells had been introduced, as already described. They may, however, be a little too numerous for the volume of water, which we estimate in these latter experiments should equal about 200 times the bulk of that in which the eggs were originally impregnated. This dilution, we find, prevents the development of any putrescent action, but does not arrest the development of hypotrichous and peritrichous infusorians in vast numbers in all of our apparatus. I am latterly inclined to regard the infusorians as a necessary evil not to be gotten rid of. In fact, I doubt if they do any damage further than to act as scavengers. I often noticed, even when the water in our apparatus was perfectly sweet, that the amoebæ, infusorians, both stalked and free-swimming species, vastly exceeded in numbers the oyster embryos present in the incubating apparatus.

I introduced a simple and effective floating collecting apparatus into the aquaria to-day. I took some corks and cut into them some distance with a knife, and then took slips of mica and pressed them into these incisions edgewise in various positions. Having arranged my slips of mica on the corks so that they could not be readily detached, the whole was placed in the aquarium so that the plates of mica would be wholly immersed. These were my collectors upon which the fry could attach itself. When fixation had been accomplished it was an easy matter to transfer these slips of mica, with the fry attached, to the stage of the microscope for more critical and exact inspection. But, alas! my expectations were not realized; I did not succeed in having any embryos attach themselves to the slips of mica in the course of further experiments. Collectors of this kind were now introduced into both apparatus No. 1 and No. 2. The temperature of the water to-day ranged from 83° to 90° F., a perceptible rise since the 22d and 23d.

July 27.—I could find to-day but very few of the embryos which were fertilized yesterday, and I sought in vain also for those of the 22d, which

would have been five days old to-day had they survived. These were found to have attained their climax of development on the 25th, after which they began to die rapidly. To-day all traces of our promising brood of the 22d have vanished from their attachments.

This ill-fortune we have supposed to be due to the high temperature of the water prevailing since the 23d. To correct this supposed unfavorable condition, Colonel McDonald has arranged for a current of well water to flow around the jars in the closed circuit to lower the temperature in the latter and maintain it at an approximately uniform point.

July 28.—I again overhauled the slips of mica forming my miniature collecting apparatus in the incubating apparatus, as well as the shells, with the result that no adherent oyster fry was discovered. The abundance of compound stalked infusorians as well as test-building species on the surface of the mica collectors was remarkable. The temperature of the water to-day ranged from 82° to 88° F.; that of the air was 96° F.

July 29.—I re-examined the collectors put into the incubating apparatus of the 22d; like the search of yesterday it resulted in discovering nothing, although the second lot of ova put in the apparatus No. 1 on the 26th ought to be now pretty well developed. The contrivance for reducing the temperature and rendering it constant in the incubator works very well; the thermometer in apparatus No. 1 indicates a practically uniform temperature ranging from 79° to 80° F. To test this last modification of the incubating apparatus, I introduced a lot of fertilized ova at 2.30 p. m. to-day.

July 30.—I find all of the eggs of yesterday dead. Examined the mica, shells, sides of the jars, and sediment, and failed to find any live embryos remaining. The temperature in the jars of the closed circuit with cooling attachment has been maintained uniformly at 78° F. all day.

July 31.—Search for embryos of the 29th repeated, with no indications of any live ones. I fertilized another lot to-day at 3 p. m. Wind very high, water in the bay very boisterous and muddy; placed a part of the eggs above mentioned in an aquarium without any provision for changing or aerating the water. I find in fact, by increasing the volume of fresh, pure water in the aquarium to about 200 times the bulk of the water used to fertilize the eggs, that I have no further trouble with putrescent action, as was shown by the subsequent behavior of this aquarium. This last lot of ova was not put into the aquarium until a decided advance in their development had been noted.

August 1.—Embryos fertilized at 3 p. m. July 31 still alive to-day at 11 a. m. in the aquarium, into which I had put a few thousands yesterday at 4 p. m. At 4.30 p. m. to-day I put in another lot of ova, which had been fertilized at 3.15 p. m. The impregnation, conducted according to my new method, was very successful. Some of this new lot were put into the closed circuit and a part into an aquarium with plants. I put none into my plain aquarium, in which I did not change the water or supply with plants.

I examined some very minute fry and spat obtained from old oysters tonged up in the deeper waters some distance off shore to-day. I removed them from their attachments as carefully as I could and placed the living translucid spat, measuring from a sixteenth to an eighth of an inch in diameter, under a compressor for more critical examination under the microscope. I counted the heart beats by my watch in these young oysters, the cardiac contractions being visible through the shell. The heart I found to pulsate at the rate of eight to twelve times per minute, and appeared to be somewhat irregular in its action.

August 2.—Examining the embryos placed in the closed circuit and aquarium yesterday, I find that they are for the most part dead, even under the most favorable conditions. The temperature in the closed circuit or McDonald apparatus with the cooling attachment remains quite constant and stands at about what it did at first. Not yet content with my results I fertilized another lot of eggs at 3 p. m. to-day.

August 3.—I fertilized another lot of eggs to-day at 12 m. The lot of the previous day appear to be dead; cannot find any alive in the apparatus.

August 4.—Eggs and embryos of yesterday have disappeared. The dead embryos and unimpregnated eggs appear to have become the prey of large numbers of *Actinophrys sol*, a sun animalcule, which has multiplied rapidly in the closed circuit and aquaria. I find in fact some of these animalcules embracing and enveloping dead oyster eggs, which they appear to grasp and surround bodily with their own living sarcode. They appear to me to be really scavengers, and not at all destructive to living oyster embryos which have begun to swim. In fact the *Actinophrys* cannot pursue its prey, being very slow in its movements, and progresses with a very deliberate rolling motion; not swift enough to follow a healthy young oyster provided with a well developed velum.

August 5.—The density of the water in St. Jerome's Creek ranges from 1.007 to 1.0095 according to the standard hydrometers used by the United States Coast Survey. At the beach opposite the barges the density was found to be 1.01 and a quarter of a mile off shore it was found to be about the same. For the determination of the density off shore I am indebted to the kindness of Dr. J. Alban Kite, of the steamer Fish Hawk. The specific gravities indicated above are greatly below the average of the ocean, as appears upon comparison with a table given by Young, in his Physical Geography, where it is stated that the specific gravity of the water of the ocean ranges from 1.02548 to 1.02919. The waters of the Chesapeake do not appear to have a density much above that of the Black Sea, even near their confluence with the Atlantic at Hampton Roads, where the specific gravity is 1.014. As one recedes from the mouth of the bay to the north the density diminishes, so that over a large part of its area it is practically little more than brackish. Along shore and in the estuarine prolongations of the bay inland is where the oyster of the Chesapeake is at home. From their prolonged stay generation after generation in water of approximately the same specific

gravity they have become adapted to it, as would appear by the facts to be cited in the sequel.

I impregnated two lots of eggs in water of specific gravity 1.009, and in water of specific gravity 1.021 respectively, the latter having been prepared artificially from fresh water to which sea salt had been added. This experiment showed us that the Saint Jeromes oysters could not be impregnated in water as dense as the last mentioned. The milt was killed by increasing the specific gravity even to a comparatively moderate degree. The eggs sank in water of the greater as well as lesser specific gravity. The spermatozoa became immobile in the denser water almost immediately, or in that which was abnormal to them. This experiment was repeated, in order to verify my conclusions, with the same result as before. A specific gravity of 1.013 was the limit of change which appeared to be endurable by the spermatozoa. These are singular facts, and show how nicely the vital conditions of the oyster have been gradually adapted to the environment. These facts appear to indicate that the characters of the protoplasm of a species themselves become specific in consequence of such adaptations.

The embryos of day before yesterday I find to be dead. Both lots of to-days' eggs poor; spawn is apparently getting scarce. Myriads of spat, I find, have caught on the shells in the natural beds out in the bay off the barges. This young spat measures from ½ millimeter up to a quarter of an inch in diameter. It must have caught for the most part within the last two weeks.

August 6.—I found young oysters to-day on the shells of the old ones measuring only one-ninetieth of an inch in their shortest diameter. This is about the size which was asserted by me to be the limit of the dimensions of the fry two years ago.* The shell of the spat develops continuously from the rim of that of the fry, but presents a totally different microscopic character. Both dissolve readily in acetic acid under the microscope, leaving the organic matrix of conchioline behind. The fry shell has well-marked lines of growth like that of the spat, but homogeneously transparent, and, unlike the shell of the spat, does not have its carbonate of lime arranged prismatically in an organic matrix. It looks like a *Pisidium* when viewed from the side, and like a *Cardium* when looked at from the end, being very ventricose and perfectly symmetrical. After decalcification with acid the line of demarcation between the spat shell and that of the fry remains indistinctly marked in the matrix. The horny membranous matrix afterwards dissolves very slowly in caustic potash. It has been very hot to-day, the air being 93° Fahr. in the shade. The temperature of both air and water are

* See first series of these investigations, in Appendix A, to Report of T. B. Ferguson, A Commissioner of Fisheries of Maryland, Hagerstown, 1881, pp. 59, figures 6 and 7, in Report entitled "An account of experiments in oyster culture and observations relating thereto, made at Saint Jerome's Creek, Maryland, during the summer of 1880," by John A. Ryder.

unfavorable for our work. Embryonized ova in aquaria all have died and begun to disintegrate.

August 7.—I had a large lot of oysters opened to-day; some of them from the deeper water of the bay. The spawn appears scarce and poor in quality, judging by the physical tests already described. I fertilized another lot of eggs at 11 a. m. Temperature of the water to-day has ranged from 87–90° Fahr.

August 8.—Embryos of yesterday's lot mostly dead. A lot impregnated to-day at 2 p. m., which were apparently in very fine condition at 3 p. m., in water of specific gravity 1.009, or that usual in Saint Jerome's Creek. Put aquarium and closed circuit in operation with water of a specific gravity of 1.013. Temperature, 80° Fahr.

August 10.—Upon making an examination of the aquaria and closed circuits to-day I find a very few embryos of the 8th still alive, but weakly, with vesicular watery prominences apparent on their surfaces. Vast numbers of a brownish diatom have now made their appearance, especially in one of the aquaria, in association with *Amœba radiosa.*

August 11.—I made the last examination of the apparatus to-day. The diatoms which were observed yesterday are now more numerous than ever in the incubating apparatus. They are brownish, with a boat-shaped central portion, with a styliform prolongation at either end. It is the same type of diatom, the silicious tests of which I have found more abundantly than any other in the intestine of the adult oyster. They have multiplied with enormous rapidity, showing that it was not the purity of the water which was lacking to favor the growth of the oyster embryos. The latter have entirely disappeared, in spite of the careful search instituted for the purpose of finding them. The fine lot of eggs fertilized on the 8th instant have amounted to nothing.

In order to see if I could catch some natural spat in the oyster pond I had a frame constructed to hold a number of panes of ordinary window glass. The frame was arranged to float, and had the bottom closed with a coarse wire screen. Upon this wire screen I placed a number of spawning oysters, then arranged the glass plates above them and left the structure floating from a temporary anchorage provided for the purpose and arranged for the convenience of the observer in making the examination of the collector. I found, however, that a large amount of gelatinous, transparent, slimy matter soon covered the plates of glass. This slimy matter I found, as I had previously learned, was largely composed of the lowest and most destructive vegetable organisms—*Vibriones*, *Bacteria*, and *Micrococci*—which I did not determine with precision. After failing, during several examinations, to find any young oyster fry or spat, I abandoned the project for the time being, with the hope that I might resume the investigation at another time. My object was to get the fry to adhere to some transparent basis upon which I might examine it with the microscope in a natural and undisturbed condition.

Our observations closed with this date. We left the station on the next day—the 12th of August.

Recapitulating, we have learned that it is easy to keep the water in the incubators pure and sweet. We found that it was not safe to alter the specific gravity of the water which was normal to the eggs and spermatozoa. We learned, too, that with the highest temperatures we did not get the best results. Our experience with the fixation of the fry was very unsatisfactory, but we have observed enough to lead us to the conclusion that the fixation may occur very early or within twenty hours of the time of fertilization. We have found that we were previously in the habit of using too much milt; that this tended to establish putrescent action in the water in which the embryos were developing. The air-blast did not prevent the putrescent action alluded to when too much milt was used; in fact we abandoned it after discovering that we got just as good results without its use. Every adverse condition which we could think of was met by us with some proviso in the arrangement of our apparatus, yet we cannot claim a full measure of success. We have materially improved the extraction of the eggs and milt from the adults, and made the methods of fertilization more simple and effective by using less milt. After dealing with many millions of ova, under a great variety of conditions, it is natural that we should have made some progress, as indicated by the foregoing recital of our experiences. The effect of free caustic lime added in solution to the water in the incubators was not clearly of any advantage, nor was the presence of oyster-shells of apparently any more importance, as was shown by our final experiments. The amount of carbonate of lime in the water necessary to the oyster is necessarily very minute. On the chalky coast of the English Channel lime is found only in the proportion of .0057 parts to 100 of water, and the Rhine at Bonn, it has been estimated by Bischof, would supply lime enough to form a mass of oysters covering four square miles to a depth of a foot. It must also be borne in mind that the great tributaries of the Chesapeake are constantly carrying vast supplies of lime into the bay in an imperceptible form. That artificial supplies of lime will determine the more rapid development of the shell of the embryo oyster appears to me not yet very clearly demonstrated. The difficulties in our way are probably not as great as we suppose, and the simple and practical manner in which some one will one day solve the question may very probably surprise all of us.

[Since the foregoing was written M. Brandely has published the results of his work upon the Portuguese oyster, upon which he was engaged at the very time we were conducting the experiments above described. An even simpler method than that devised by M. Brandely was found to give very promising results at the hands of the writer at Stockton, Md., on the premises of Messrs. Shepard and Pierce; and by that method, devised and put into practice within the next twelve months, a very important advance was made in the practical culture of the American oyster, as already very fully described in a paper, by the author, cited in the first part of this article.]

XXV.—THE METAMORPHOSIS AND POST-LARVAL STAGES OF DEVELOPMENT OF THE OYSTER.

By John A. Ryder.

Professor Brooks in his elaborate paper on the development of this mollusk, in the report for 1880 of the commissioners of fisheries of Maryland, page 25, observes, in relation to the oldest embryos figured by him (Figs. 44 and 45, Plate VI): "The American oyster reaches this stage in from twenty-four hours to six days after the egg is fertilized, the rate of development being determined mainly by the temperature of the water." He further states, "All my attempts to get later stages than these failed through my inability to find any way to change the water without losing the young oyster, and I am therefore unable to describe the manner in which the swimming embryo becomes converted into the adult, but I hope that this gap will be filled either by future observations of my own or by those of some other embryologist." These remarks applied to the American oyster, *Ostrea virginica*. Since then Prof. H. J. Rice has described what he has called the *proboscis stage* of development of the embryo oyster, said to be assumed after the oldest stages figured by Brooks have been passed over. This stage the writer has never seen, or if it was observed, he has failed to note what has been found by Rice.

The embryo European oyster, *O. edulis*, has been discussed by Professor Huxley,* and his remarks upon the manner of its metamorphosis, on account of their clearness, I take the liberty of reproducing here with some slight verbal changes; I have also borrowed one of his figures in order to make his language more easily intelligible. His remarks are as follows:

"The young animal which is hatched out of the egg of the oyster is extremely unlike the adult, and it will be worth while to consider its character more closely than we have hitherto done.

"Under a tolerably high magnifying power the body is observed to be inclosed in a transparent, but rather thick shell (Fig. 1, L), composed, as in the parent, of two valves united by a straight hinge, *h*. But these valves are symmetrical and similar in size and shape, so that the shell resembles that of a cockle more than it does that of an adult

* In a lecture delivered at the Royal Institution, Friday, May 11, 1883. Published in full in the English Illustrated Magazine for October and November, 1883, pp. 47–55 and 112–121.

oyster. In the adult the shell is composed of two substances of different character, the outer brownish, with a friable prismatic structure, the inner dense and nacreous. In the larva there is no such distinc-

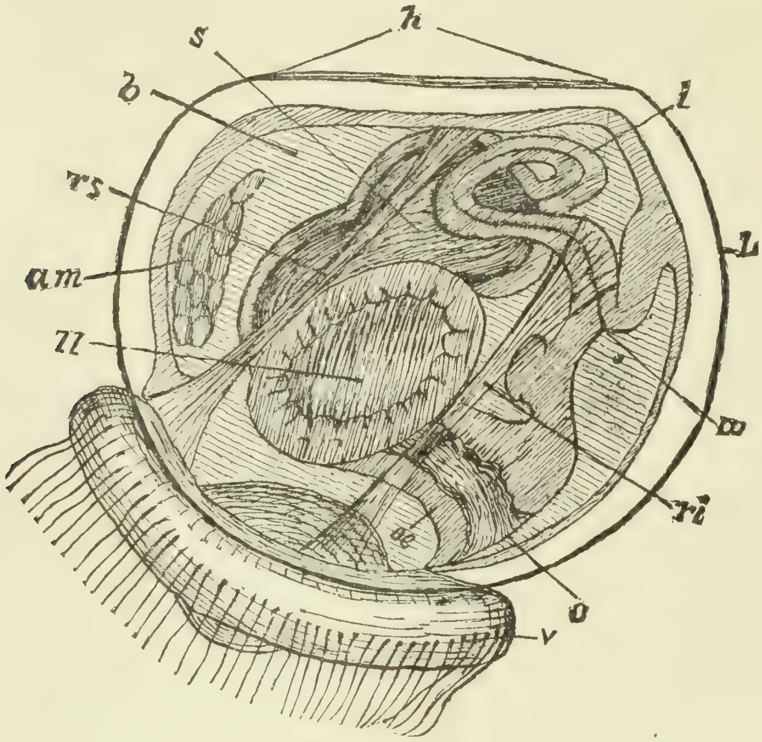

FIG. 1.

tion, and the whole shell consists of a glassy substance devoid of any definite structure.

"The hinge line answers, as in the adult, to the dorsal side of the body. On the opposite or ventral side, the wide mouth *o* and the minute vent *a* are seen at no great distance from one another. Projecting from the front part of the aperture of the shell there is a sort of outgrowth of the integument of what we may call the back of the neck, into a large oval thick-rimmed disk termed the *velum*, *v*, the middle of which presents a more or less marked prominence. The rim of the disk is lined with long vibratile cilia, and it is the lashing of these cilia which propels the animal, and, in the absence of gills, probably subserves respiration. The funnel-shaped mouth has no palps; it leads into a wide gullet, and this into a capacious stomach. A sac-like process of the stomach on either side (the left one *ll* only is shown in Fig. 1) represents the 'liver.' The narrow intestine is already partially coiled on itself, and this is the only departure from perfect bilateral symmetry in the whole body of the animal. The alimentary canal is lined throughout with ciliated cells, and the vibration of these cilia is the means by which the minute bodies which serve the larva for food are drawn into the digestive cavity.

"There are two pairs of delicate longitudinal muscles, *rs ri*, which are competent to draw back the ciliated velum into the cavity of the shell, when the animal at once sinks. The complete closure of the valves is

effected, as in the adult, by an adductor muscle, *am*, the fibers of which pass from one valve to the other. But it is a very curious circumstance that this adductor muscle is not the same as that which exists in the adult. It lies, in fact, in the fore part of the body, and on the dorsal side of the alimentary canal. The great muscle of the adult, on the other hand, lies on the ventral side of the alimentary canal and in the hinder part of the body. And as the muscles, respectively, lie on opposite sides of the alimentary canal, that of the adult cannot be that of the larva which has merely shifted its position; for, in order to get from one side of the alimentary canal to the other, it must needs cut through that organ, but as in the adult, no adductor muscle is discoverable in the position occupied by that of the larva, or anywhere on the dorsal side of the alimentary canal; while, on the other hand, there is no trace of any adductor on the ventral side in the larva, it follows that the dorsal or anterior adductor of the larva must vanish in the course of development, and that a new ventral or posterior adductor must be developed to play the same part and replace the original muscle functionally, though not morphologically.*

"This substitution is the more interesting since it tends to the same conclusion as that towards which all the special peculiarities of the oyster lead us; namely, that, so far from being a low or primitive form of the group of lamellibranchiate mollusks to which it belongs, it is in reality the extreme term of one of the two lines of modification which are observable in that group. The *Trigoniæ*, the arks, the cockles, the fresh-water mussels and their allies, constitute the central and typical group of these mollusks. They possess two subequal adductors, a large foot, and a body which is neither very deep nor very long. From these, the series of the boring bivalves exhibits a gradual elongation of the body ending in the ship-worm (Teredo) as its extreme term. While, on the other hand, in the sea-mussels, the *Aviculæ* and the scallops, we have a series of forms which, by the constant shortenings of the length and increase of the depth of the body, the reduction of the foot, the diminution of the anterior of the two adductors, and the increase of the posterior, until the latter becomes very large and the former disappears, end in the oyster.

"And this conclusion that the oysters are highly specialized lamellibranchs, agrees very well with what is known of the geological history of this group, the oldest known forms of which are all dimyary, while the monomyary oysters appear only later.

"When the free larva of the oyster settles down into the fixed state the left lobe of the mantle stretches beyond its valve, and applying itself to the surface of the stone or shell to which the valve is to adhere,

* The larva of the cockle has at first, like the oyster larva, only one adductor, which answers to the anterior of the two adductors which the cockle possesses in the adult state.

secretes shelly matter, which serves to cement the valve to its support.* As the animal grows, the mantle deposits new layers of shell over its whole surface, so that the larval shell valves become separated from the mantle by the new layers, which crop out beyond their margins and acquire the characteristic prismatic and nacreous structure. The summits of the outer faces of the umbones thus correspond with the places of the larval valves, which soon cease to be discernible. After a time the body becomes convex on the left side and flat on the right; the successively added new layers of shell mold themselves upon it; and the animal acquires the asymmetry characteristic of the adult."

In my article entitled "On the fixation of the fry of the oyster," published in the Bull. U. S. Fish Commission, II, 1882, p. 383–387, I have already described the manner in which the young embryo of *O. virginica* affixes itself by the border of the mantle. Upon comparing the above-quoted description, given by Professor Huxley, of the way in which this takes place in that of *O. edulis*, it will be observed that there is little or no difference in this respect between these two species. I have, however, entered more fully into a description of the manner in which the metamorphosis into the spat shell is effected than was done by Huxley, having indicated in my Figs. 5, 6, 7, and 8 the pecteniform or scallop-like appearance of the shell of the spat in its very young condition, with the dorsally straight-bordered anterior and posterior alæ of the valves which are developed at this time. It is also a very significant fact that the young oyster spat should resemble in its early condition the form permanently assumed by some of its nearest allies, the pectens. And it may be explained only by the well established doctrine that even highly specialized forms tend to reassume during the early stages of their existence the form of the type from which they have been evolved.

The hinge border of the embryos of both *O. virginica* and *O. edulis* is straight, and in both species there is an umbo developed on both valves of the larval shell during its later stages. This character is also observed in the young stages of native oysters from other parts of the world, as in those from the Pacific, on the coasts of California and Peru. It is therefore very probably characteristic of all of the members of the family.

My observations upon the internal organization of the young spat were made upon some that were removed from the smooth inner surface of the dead oyster and clam shells, which had been sown on the bottom in Cherrystone River, Virginia, by Captain Hine and Mr. W. H. Kimberley in the spring of 1881. A number were removed from such situations without injury, so that I could study them under the micro-

[* The young oyster is not cemented directly to its fixed basis by the calcareous substance of the shell, but by the brown cement substance which is quite apparent on the outer surface of the valves. This layer answers to the periostracum of the adult, and is probably what was really meant by the speaker.]

scope as transparent objects in the living condition, and with the cilliary structures in lively movement and the heart pulsating as though nothing had occurred to injure them.

The shells of the smallest specimens I obtained during the season of 1881 were about one-eighth of an inch in their greatest diameter or about ten times as large as the shell of the fry when it ceases to swim. Since then much smaller specimens have been obtained. Lest any one should suppose that I may have mistaken the young of *Anomia*, or the "silver-shell," for that of the oyster, let me here remark that they are very readily distinguished even when very young. The valves of young "silver-shells" are lustrous, very smooth, and thinner than those of the oyster; the shell of the young of the latter is never lustrous, and is almost always marked with bands of a dark or purple color which run from the hinge in a radial manner to the edges of the valves. There is no mistaking these differences, and only a little experience will enable any one to distinguish the very smallest spat of *Ostrea* and *Anomia* apart.

Another means of distinguishing the spat of *Anomia* from that of *Ostrea* is afforded by two other characters not before mentioned. There is no pigment developed in the shell of the former, while almost invariably in the young oyster a well-marked deep purple streak runs from the hinge-border of the valves to the free-margin, especially in the upper or left one. This streak also usually widens as it approaches the margin of the valve and coincides with the radius of the shell in which the great posterior adductor is developed. This streak is, in fact, in great measure due to the fact that the insertion of the adductor in *O. virginica* is deeply pigmented throughout life, the deposit of color at first shimmering through the thin translucent valves of the young oyster. It is probable that in the spat of *O. edulis* no such purple streak is present on the upper valves, because in that species the insertion of the adductor is rarely if ever pigmented. The purple streak in the upper valve of the spat of *O. virginica* also serves to distinguish which is the posterior or upper margin of the shell, upon mere superficial inspection, inasmuch as when at all well developed it is nearest the posterior margin of the shell. Occasionally spat of *O. virginica* is found in which pigment is almost entirely wanting.

A second character which distinguishes the spat of *Anomia* from that of *Ostrea* is the following: In *Anomia*, when the shell is forcibly detached from the surface to which it is affixed, both the upper and lower valves may be lifted from their nidus; in *Ostrea*, on the contrary, it is only the upper valve which can usually be removed, the lower one being firmly cemented to its surface of attachment. The lower valve of the spat of *Anomia* is never cemented to the surface of fixation, the lower valve of *Ostrea* invariably. The byssal plug of *Anomia* in its spat stage, as well as in the adult, finally perforates the lower valve, and this is the only attachment of the animal to its fixed basis. As elsewhere men-

tioned by the writer, the lower valve of *Ostrea* may be cemented to its basis of attachment over its entire outer surface till it has attained a size of two inches in diameter.

Fig. 2 represents the small spat of which I have just spoken, magnified thirty-two times, and which presents so many peculiarities as compared

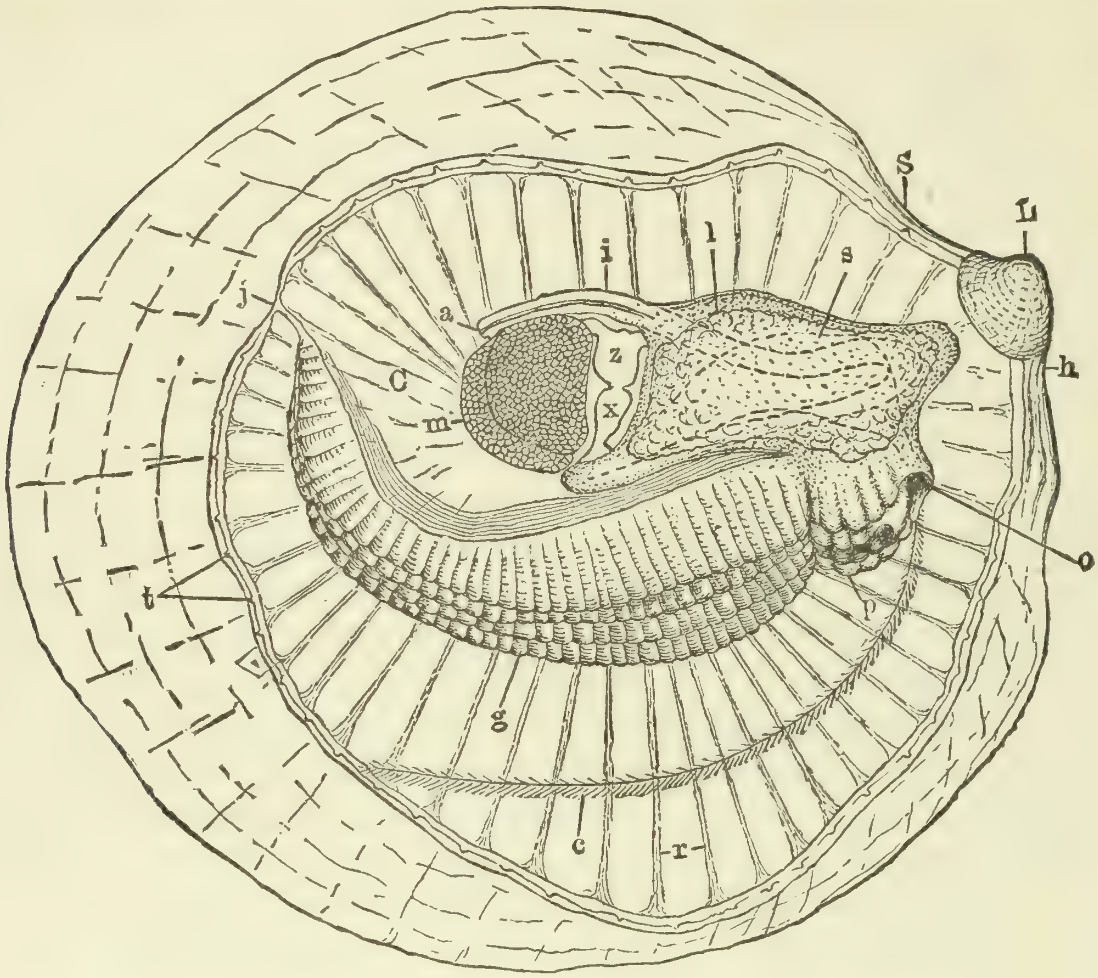

Fig. 2.

with the adult that it will be desirable to describe it somewhat in detail.

The shell in individuals as small as this up to three-fourths of an inch in diameter is nearly always almost round or oval in outline, and very thin, so as to be easily broken with pressure by the thumb or finger. In very young ones, like the one figured, the valves are still transparent, but when a little older they become, first, translucent, then opaque, as they acquire increased thickness. In the case of Fig. 2, the shell, which formerly covered the swimming or fry stage, is attached at the hinge ends or beaks of the valves. It measures about $\frac{1}{90}$ of an inch in diameter, and shows concentric lines of growth, with apparently well developed beaks, or umbos, which are also doubtless present in the young spat of the European oyster at a late stage, or after fixation. Only the larval shell of the right side is indicated at L in the figure; it is permanently fixed to that of the spat shell S, but does not present the microscopic characters of the latter. The former appears to be smooth and concentrically laminated, and not altogether structureless; the latter, under a power of 150 diameters, shows that it is made up of

very minute transparent polygonal prisms of carbonate of lime arranged vertically to the plane of the shell; each of these prisms measures $\frac{1}{7500}$ of an inch in diameter, and gives the appearance of an irregular tesselated pavement under the microscope. They are held firmly together by an organic material more or less nearly identical with the hard outer crust of insects. In the latter this material is called *chitin;* in the shell of the mollusk, where it binds the prisms of lime solidly together, it is called *conchiolin.* As development advances the shell is thickened from within by the deposition of lime carbonate on the inner surface of the valves; this lime carbonate is secreted from the blood of the animal and is primarily derived from the food; the organ, which is the effective agent in laying down this deposit, is the mantle, the margin of which is provided with sensitive feelers or tentaculæ as indicated in an undeveloped condition by the small wart-like prominences at the border of the mantle organ at *t.*

The mantle is a highly sensitive structure, and is provided with radiating muscular filaments, *r*, which run through its substance outwards to its margin in every direction. These radial muscular bands are very distinct in the young, as indicated in our figure. In young oysters and "silver-shells" its margin is sometimes seen protruded beyond the edges of the valves, when the animal has its shell open, and is quietly feeding. The mantle covers the right and left sides of the soft body of the oyster like a cloak; the leaves of opposite sides are joined together at the middle line near the hinge *h* and at a point near the ventral hinder end of the body J where the gills *g* end. The extent of the union of the right and left leaves of the mantle behind or below the hinge I have not been able to make out clearly in these young specimens of spat. Only the left leaf of the mantle is shown in Fig. 2.

The gills *g* of the spat are well developed at this early stage, and extend between the right and left leaves of the mantle from the palps or lips *p* to the point *j*. They are much like the gills of the adult, but above them the upper gill chamber is wider, and the cloacal space C, which lies between the adductor muscle *m*, the hinder part of the gills and the leaves of the mantle at the sides, is remarkably spacious. The gills are at this stage already very evidently of the type seen in the adult; they are really four elongated pouches suspended between the leaves of the mantle with vertical rows of pores arranged in the furrows on their surface; these pores convey the water into the hollow gills, from which it passes through rows of large holes above into the upper gill chamber and out by way of the cloaca C.

In the spat, I also find in the course of more recent studies that there is a very delicate branchial skeleton formed of very fine quadrangular meshes of a chitinoid substance, which, as in the adult, serves to give support to the soft tissues of the gills. Whether there is present a delicate thin membrane in the skin covering the mantle of the spat,

composed of very fine interlacing fibers, as in the adult, I am unable to state.

The palps or lips of the young spat at this stage are not at all like the palps of the adult. They are much shorter, as indicated at *p*, but the upper or anterior lip passes like a hood in front of the mouth *o*, and the lower, hinder, and inner one bends backwards on either side behind the mouth. In the adult, the inner surface of the outer pair of palps or upper lips are furrowed with numerous shallow grooves; in the lower lip the outer and upper surfaces are so furrowed. In the young, a different state of affairs exists. Here furrows can scarcely be said to be present; but the lips are apparently divided into more or less distinct conjoined parallel lobes; their number, unlike in the adult, is also very few, or about 4 to 5. I have counted over one hundred folds and furrows on one side of the lower lip or palp of the adult: we would naturally expect to find them fewer in number on the same parts in the young animal.

At the hind or ventral borders of the palps their edges seem more or less nearly continuous with the gills, and, as there are four of the latter as well as four posterior ends to the lips, it would appear probable that both palps and gills originated from very nearly the same primitive structure. That is, suppose the four folds or rows of branchial processes of which the gills are formed were at first developed from a tract of epiblastic tissue, or the skin-layer proper, from which the palps also are differentiated, and it is possible to conceive of them as having been developed from nearly the same type of rudiments, that is, longitudinal folds of epiblast which were at first continuous.

The mouth of the spat in Fig. 2 opens downwards and not so directly forwards or dorsally as in the adult. This fact, taken in connection with the singular change of place undergone by the mouth in its passage from the fry stage to that of the spat, is significant and will be discussed farther on.

The ciliated band *c* in Fig. 2 gives an ideal representation of the way in which the cilia on the inner surface of the mantle are arranged and how they may be brought to act in conveying the food to the mouth *o*. The gills also are of course clothed with cilia, as in the adult.

The course of the intestine *i* is very much the same as in the adult; the vent *a* lies just over the adductor muscle *m*, and the stomach *s* is enveloped by the brown liver *l*, which appears to constitute the principal portion of the body-mass, exclusive of the intestine and stomach, at this stage. The heart is divided into a pair of auricles, *x*, below and a medially divided ventricle, *z*, above, and like the heart of the adult, lies in a crescent-shaped heart-cavity. Where the intestine returns and bends sharply backwards on itself above the mouth, there is a rounded projection of the body-mass forwards, which is not seen in the adult.

The most striking changes in the relations of the intestine after the larval condition is past and that of the young oyster has been assumed

as spat, may be observed upon comparing together Figs. 1 and 2; Fig. 1 shows a larva viewed from the left side; Fig. 2 represents the spat as seen from the right side, but in both the course of the intestine is displayed. In Fig. 1 the single loop of the intestine *i* does not extend nearly as far forward anteriorly as in Fig. 2, it is therefore evident that during the metamorphosis this loop is prolonged so that in the adult it actually crosses the gullet, but the intestinal canal as a whole remains flexed upon itself in much the same manner from the later larval stage onwards with its anterior flexure thrown forward over the left side of the stomach. The posterior end of the stomach, together with the first flexure of the intestine is afterwards considerably depressed, while the œsophagus is thrown upwards and between the first flexure of the intestine and the rectum, the permanent posterior adductor muscle *a* (Fig. 2) is developed, very probably from wandering cells which have dehisced from the visceral cavity or blastocœl of the embryo.

Upon comparing the two figures it would appear as if the mouth *o*, Fig. 1, together with the œsophagus and forepart of the stomach, would have to be rotated through an angle of nearly ninety degrees in order to bring it into the relation with the hinge *h*, as shown at *o*, in Fig. 2. This alteration in the relative positions of the viscera during the passage of the larva into the adult condition is one of the most striking changes which occur during the metamorphosis.

One of the most conspicuous differences between the symmetrical larva and the young spat is the absence of gills in the former and their presence in the latter. These grow out as blunt fleshy processes, behind the mouth *o*, and in front of the anus *a* (Fig. 1), after a pallial sinus has been formed in that position. Sections which I have prepared of very young spat seem to show that the development of the branchiæ is not completed until some time after the fixed and spat stage has been assumed. Cross-sections of very young spat one-eighth of an inch in diameter show only two gill pouches developed posteriorly, instead of four, as in the adult; this would indicate that the outer gill pouches are formed during the young condition of the spat, and some time after the symmetrical larval condition has been passed. As far as the branchial system is concerned it therefore appears evident that it is completely developed after the true larval condition is over, and the metamorphosis is otherwise complete.

The liver, according to the testimony of a number of investigators, arises as a pair of hollow outgrowths on either side of the stomach. It seems therefore to develop from bilaterally symmetrical rudiments like the shell, and that its subsequently more complex structure is a result of secondary or later processes of growth, affecting mainly the walls of the original right and left hepatic lobes. These hollow lobes seem to arise rather from the lower lateral portions of the gastric dilatation of the alimentary canal of the embryo, and traces of this original symmetry are not wanting when we come to observe the relations of the

hepatic structures to the stomach in the adult, which is very apparent when cross-sections are examined. While there seems to be only two hepatic diverticula in the embryo, from the alimentary canal it is evident that the liver in the adult opens into the gastric cavity by way of four principal ducts, one pair being more anterior in position than the other; this may be a result of the transverse division of the primitive ducts, just as the lobules of the liver are multiplied by the upgrowth of folds on the walls of pre-existing follicles, by which the latter are again and again subdivided and multiplied in the course of further growth. The hepatic tissues are most extensively developed below and at the sides of the stomach in the adult, sparingly at the upper part of its sides, and are altogether wanting immediately above it along the median line. Together with its increase of size the number of its follicles increases very greatly so that there may be thousands in the adult, whereas there were at first but two in the embryo.

Cross-sections of the soft parts of the young spat show the hepatic follicles proportionally larger than in the adult, but far less numerous, there being at most not over a few dozens present in spat of the size shown in Fig. 2.

The connective tissue also, which forms so large a proportion of the soft parts of the adult, is very sparingly developed in the spat, of the size here figured. In the young larva the connective tissue appears to be represented only by a few multipolar cells and the cells which enter into the formation of the anterior adductor and retractor muscles of the velum. In the spat there does not appear to be any connective tissue or mesoblast between the liver follicles (hypoblast) and the mantle (epiblast), which forms the integument or body walls of this stage. The development of connective tissue in such quantity as is found in the adult therefore occurs during the time intervening between the development of the earliest condition of the spat and the stage of growth reached within the next following twelve months. In the course of its development the connective tissue remains in part spongy, and has a lacunar structure in some parts, but in certain parts of the body-mass its component cells enter directly into the formation of the walls of the principal vessels which are devoid of an endothelial lining. As the stratum of connective tissue increases in thickness, the organs of epiblastic origin, the mantle and gills, and those of hypoblastic origin, the alimentary canal and its appendages, are more widely separated from each other by it.

The vascular system and heart both originate from the connective tissue or mesoblast. In the youngest stages of the larva there is no heart developed, and inasmuch as the walls of the vessels traversing the body-mass in the adult are formed of connective tissues alone, there can, of course, be no vessels developed in the larva, where the connective tissue is still practically undeveloped as a discrete layer. The colorless

blood-corpuscles of the oyster are also probably not developed in appreciable numbers until after the true larval stage is past.

The intestine of the larva is a simple internally ciliated tube; indeed the entire alimentary canal appears to be ciliated from the mouth to the vent, and, as in the adult, there do not appear to be anything like unstriped annular muscular tissues developed around the intestine so as to produce anything comparable to the peristaltic action of the intestine observed in worms, arthropods, and vertebrates; the food is carried into digestive tract and the excrements out of it by the action of the cilia alone.

The intestine of the spat long before the stage here figured has been reached already contains food or its indigestible remains, but the longitudinal fold found in the intestine of the oyster, as well as in the intestines of many other lamellibranks, is but feebly developed in the hind gut of young oyster spat. It is, however, present as a pretty well marked ventral ridge or slight induplicature of the intestinal wall, but it is evidently not clearly folded inward upon itself, as in the adult, until the animal is much older than the stages studied by the writer.

The retractor muscles of the velum in the larva do not appear to be homologous with any of the muscles of the spat or the adult, and are analogous only to the radial muscular bundles *r* of Fig. 2. These radiate from around and near the insertions of the great posterior adductor *m*, and are most strongly developed in the posterior and ventral halves of the mantle-lobes (in Fig. 2 these radiating pallial muscles are perhaps too strongly indicated about the hinge-border of the young animal). The retractors of the velum appear to traverse the blastocoel in the embryo. The pallial retractors, on the other hand, are embedded in the connective tissue of the mantle next to the outer epithelial covering or epidermis. The radiating pallial muscles become more complex with advancing age, and as the adult condition is approximated, and while there is a decided thickening of the margin of the mantle in the spat there is not as strong a development of the marginal muscle as in the adult. In the adult the radiating pallial muscular bundles also repeatedly divide as they pass towards the margin of the mantle, a trait which they possess to a much less marked degree in the spat. The radiating and marginal muscles have their fibers very much interlaced, so that a very complex arrangement of the muscular fibers is finally developed at the edge of the mantle.

The fringe of the tentacles along the border of the mantle of the spat is also much less strongly developed than in the adult. They are, in fact, in the young spat mere papillary elevations, as shown in Fig. 2, and at first there appears to be only a single row of them, whereas there are two rows in the fully grown animal. As the animal increases in size these marginal tentacles of the mantle also increase greatly in length until they become finger-like in form, with a usually more or less well-marked purplish coloration throughout their epidermis and about

their bases. In cross-sections through the soft parts of the young spat the margin of the mantle is grooved the same as in the adult. The two marginal ridges are evidently the rudiments of the two rows of tentacles in the adult.

The extent to which the right and left mantle leaves are united dorsally I have not made out accurately, but it is evident that they are joined together for at least the length of the straight hinge of the larval shell. The development of the cucullus ventrally, and the velamen dorsally, evidently must occur after the transformation of the larva into the condition of spat.

Davaine makes the statement that the velum appears to drop off some time about the end of the larval period. Gerbe, on the other hand, asserts that the velum is transformed into the palps. There are marked discrepancies between the figures of oyster embryos which have been published by various authors; for instance, in Fig. 1, from Huxley, the intestine arises from the end of the gastric dilatation of the alimentary canal, but in Horst's figure of the same stage it is shown to arise from the middle ventral part of the stomach. In other respects the figures of these authors agree pretty closely; Môbius also represents the intestine as arising from the middle of the under side of the stomach in the embryo, and approximates the mouth and vent more in his figure than do the two preceding authors. He also indicates the presence of a third strong retractor muscle which takes its origin from near the hinge and is inserted into the body-wall near the vent. Davaine's interpretations of the form, course, and relations of intestinal canal again differ somewhat in detail from all of the foregoing, as is shown by his figures. The figures given by Coste and Gerbe agree pretty closely; both represent the intestine as arising from the posterior extremity of the gastric dilatation, but again differ from the other au-

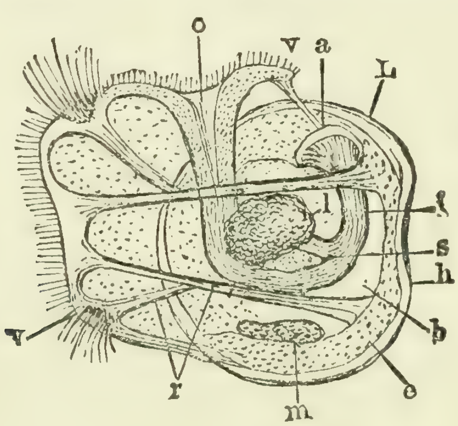

FIG. 3.

thors in the way in which they represent the insertion of the retractor muscles into the velum.

Fig. 3 reproduces the interpretation of the structure of the embryo of *Ostrea edulis* as given by the two last-mentioned observers.

The study of the embryos of *O. virginica* and *O. angulata* is attended with much more difficulty than that of *O. edulis*, because the eggs of the

latter are twice as large in diameter as those of the two first mentioned, and, as a consequence, their embryos are only about one-eighth as large in volume as those of the last named when they have attained the free-swimming or veliger stage of development. The relatively very small size of the embryo American oyster is therefore unfavorable to its satisfactory study; indeed, it is very reasonable to suppose that its investigation, for this reason, would be vastly much more difficult than that of the young of *O. edulis.*

The following summary of the changes suffered by the young oyster in its metamorphosis into the condition of the spat may be appended:

1. The mouth in the larval oyster is nearly ventral in position, while in the adult it opens more nearly in the direction of the hinge or towards the antero-dorsal region.

2. The retractor muscles of the velum probably atrophy at the end of the larval period; if they are to be regarded as the musculature of the primitive mantle organ, they are replaced in the spat and adult by the radiating and marginal pallial muscles.

3. The intestine of the larva is a simple tubular organ; in the spat it has an internal ridge developed on one side, which finally becomes a pronounced induplicature in the intestine of the adult.

4. The anterior adductor muscle of the larva is replaced by a permanent posterior adductor in the spat and adult. (Huxley.)

5. The heart and gills are wanting in the larva; they are developed as post-larval organs. The gills are at first represented by only two folds, the outer pair are developed later, and apparently from before, backwards, or dorso-ventrally.

6. The connective tissue of the spat and adult, including the organs derived therefrom, seems to be almost entirely developed during post-larval life.

7. The blastocœl is mostly obliterated by the development of the connective tissues.

8. The liver is represented by a pair of diverticula which grow out laterally from the walls of the stomach of the larva; its subsequent development and subdivision into a vast number of follicles is accomplished during post-larval life.

9. Some time after fixation the larval oyster seems to lose the straight hinge border of its valves, which then acquire umbones; the valves retain their symmetry up to the time when the spat shell begins to be formed, and it is probable that most of the larval characters of the animal have disappeared when the formation of the spat shell begins; in other words, the veliger stage is past and is at once replaced by a structural condition of the soft parts which approximates that observed in the adult.

XXVI.—ON THE CAUSE OF THE GREENING OF OYSTERS.*

By M. Puységur.

WITH A SUPPLEMENTARY NOTE ON THE COLORATION OF THE BLOOD CORPUSCLES OF THE OYSTER.

By John A. Ryder.

The acquisition of a green tint by the soft parts of oysters has been observed in a great many places; at Marennes, l'île d'Oleron, Courseulles, etc., and practical as well as scientific men have long been engaged in trying to discover the cause of this phenomenon. Their observations are scattered through diverse periodical publications, to which I have been obliged to refer, for it was important to determine if their researches were of any real value, inasmuch as none of those yet undertaken seem to lead to correct and indisputable conclusions.

The first paper upon this subject which I have been able to find is by Gaillon, which was issued in the *Journal de Physique, de Chimie et d'histoire naturelle* for September, 1820, tome xci, and was republished with notes by Bory de Saint-Vincent in the *Annales générales des sciences physiques*, tome vii, Brussels, 1820, pp. 89–94.

While desiring to be concise, I cannot resist the temptation to cite some passages from the notice by Gaillon.

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"This green color," says this savant, "is attributed by some to a disease which affects these mollusks." "No," say others, "it is due to the particles (fragments) of green marine plants upon which they feed during a part of the spring and autumn." Others simply pretend that the plants cause the water to become green at certain times, and that the oyster absorbs the color from the water and retains it.

After having combated by arguments and objections, which do not seem very convincing, the views which he would reject, Gaillon at once enters upon a discussion of the subject.

"This malady," he continues, "is it peculiar to the oyster? No; for of other mollusks, some actinians which I placed in this greenish water were not slow to absorb some of the color. This last observation led

* *Notice sur la Cause du Verdissement des Huitres. Par M. Puységur, Sous-commissaire de la Marine, Chevalier de la Legion d'Honneur. Extr. de la Rev. Maritime et Coloniale, pp.* 11, 1 *pl. Paris, Berger-Levrault et Cie.* 1880.

me to suppose that the cause of the greenness was due to the water, which I supposed saturated and impregnated the substance of the oysters, rather than to a derangement of their organic functions. Reflecting upon this idea, I fixed my attention upon the upper valve of an oyster then 'greening' at the bottom of a park; I observed upon its surface very small masses of a very deep, brilliant, green color. I brought my microscope and placed upon a slide, moistened with a drop of water, one of these little, deep, emerald-green masses, which I had found on the the shell of the oyster; what was my satisfaction to find that it contained hundreds of minute attenuated animalcules, pointed at both ends. They were diaphanous at their ends and slightly tinged with green in the middle, where there were present many contractile points."

He says further: "These little beings behaved variously. Sometimes they moved with the axis of the body inclined to the direction of movement. Sometimes they would turn round like a magnetic needle upon its pivot, or they would exhibit a sudden movement of impulsion forward or in a retrograde direction; sometimes again they would erect themselves upon one end; they seemed to like to group themselves together and become entangled amongst one another without order. I have seen them dart at and attack with their pointed ends, as with a lance, other infusorial animalcules the size of which was greater than their own."

I would here close my citations from Gaillon. After having sought to discover the relationship of the animalcule, which he so laboriously describes, he decided for himself, upon the ground of the analogies which he thought he saw, to class it amongst the vibrios, and he proposed for it the name of *Vibrio ostrearius*.

In justice to Gaillon we must admit that he saw "the animalcule" which he described, and that we would not describe their movements in the field of the microscope much better than he has done, but this need not deter us from blaming him for not pushing his studies beyond the determination of the mere fact of the coexistence of these organisms and the green color of the oyster, and to have quietly accepted as a sufficient explanation of the facts the dubious *post hoc, ergo propter hoc.*

This superficial mode of investigation was wide of the mark, as regards bringing about conviction and leading to any real discovery. In another place Gaillon refers to a polemic, which may be said to have been more playful than serious, and of which a trace may be found in the *Annales maritimes (Sciences et Arts)* of 1821, pages 874 to 880, and in the same publication for 1822, pages 86 to 89. M. Goubeau de Billenerie, president of the civil tribunal of Marennes, denies absolutely the existence of the "Vibrio," and asks for its "certificate of origin."

But we find that in other respects he does not oppose Gaillon.

"My opinion," says he, "is that it is necessary to take into account the action of a combination of causes; in the first place, the situation of our *claires* on the banks along the Seudre, the fresh water of which

is mingled with that of the sea, and which is poured into our reservoirs during the spring-tides, to again be mixed with the waters of the river; in the second place, the action of a moderate temperature; then the sun and the northeast wind which brings about the above-mentioned thermal conditions; in fine, to the mode in which the parks are managed, according to methods which have been adopted after prolonged experience."

In the *Médecin Malgré lui*, when Sganarelle explains to Géronte why his daughter is mute, the reasons which he gave are, to say the least, quite as plausible as the causes invoked by M. Goubeau de la Billenerie to account for the *greening* of oysters. He invokes all the elements; the sun, the northeast wind, and then the moderate temperature along the banks of the Seudre, from September to April, that is to say, that prevailing during the coldest part of the year. This is taking into account a great many causes in order to produce such a simple effect, and reason is confounded when it is inquired what share each of these many causes has had in producing the observed phenomena. The criticism of M. Goubeau de la Billenerie is far from as valuable as the incomplete investigation by Gaillon.

In his *Voyage d'exploration sur le littoral de la France et de l'Italie*, M. Coste does not himself directly enter upon the consideration of the question which now occupies our attention. He contents himself with reporting the various opinions which others have expressed, and merely enunciates the following conclusion, p. 118:

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"Of these three opinions, that which attributes to the nature of the soil the power of greening [oysters] appears to be the most in accord with the actual facts of the case."

We shall see in the sequel that the nature of the soil is not in any sense the immediate cause of the viridity of these mollusks. This opinion, like the others, was not expressed by M. Coste as his own, but only as the most plausible amongst those which he had enumerated. A man of the character of the learned professor of the College of France would not be content to discuss this subject with the intention of merely playing upon words.

In this case, as in many others where vital processes come into play, the science of chemistry has been fruitless in the investigation of the cause of the viridity of oysters. M. Berthelot, at the request of M. Coste, sought to discover what was the true nature of the matter to which the coloration of the branchiæ of the oysters of Marennes was due, and the only results which he obtained from analyses were of an absolutely negative character.

"Summarizing our results," says the celebrated chemist, "the coloring matter found in the oysters of Marennes does not resemble that of blood, that of the bile, nor vegetable or animal coloring matters generally. The coloring matter of the blood contains, it is true, some iron, but the

properties of this matter as well as its color are very different from the latter.

M. Bonchon-Brandely, charged in 1877 with the duty of preparing a *Rapport sur l'ostreiculture sur le littoral de la Manche et de l'Ocean*, reviews briefly the method of culture by which oysters are made to assume this color, but does not touch upon its causes. He thinks it probable that the coloration is due to the absorption of the chorophyll diffused through the sea-water, an opinion which is without foundation, because chlorophyll, which is soluble in alcohol, ether, benzine, &c., is altogether insoluble in water.

Finally, M. Paul Petit published an article in the *Revue Pharmaceutique* for 1878, No. 7, page 112, from which we extract the following:

"The learned French diatomologist, M. A. de Brébisson, has observed in the oyster parks of Courseulles a peculiar diatom to which he has given the name of *Amphipleura ostrearia*.

"This species assumes in the portion not occupied by the endochrome a bluish-green tint, but this disappears after dessication. We have supposed, says M. de Brébisson in the note which accompanies his drawing, that this species communicated its color to green oysters, and that it seemed to him that it assumed this color when it grew in a park, which had a tendency to cause the oysters contained therein to become green."

In the beginning of his article, M. Paul Petit mentions the analyses made by M. Balland, pharmacist-major, and M. Gaillard, chief pharmacist of division, at Alger, and who declared that they had found copper in green oysters. M. Gaillard himself concludes from his observations that this was because some process was fraudulently employed to color the mollusks, and that it consisted merely in immersing them in a solution of a salt of copper, and leaving them in it till they were saturated by it.

We will not deny that these chemists may have found copper in these oysters, since they make the assertion, but our own direct experiments have shown—

1. That an oyster which is placed in a bath of sulphate of copper is not colored at all.

2. That death quickly follows when they are plunged into such a mixture.—

I think I have now completed the historical review of the researches which have been made up to the present time to discover the causes of the greening of oysters, and I hope I have shown that none are very exhaustive, the truth still remaining to be discovered in regard to this subject; but, before passing to the observations and experiments which we have made jointly, I would give expression to my sense of obligation for the friendly and able assistance which was very willingly rendered to me during his stay at Croisic in the spring of 1877, by Dr. Bornet, the distinguished algologist, well known to the learned world, and as the continuator of the labors of the lamented M. Thuret.

I received a commission in 1875 from the department of the marine

to establish some experimental parks on the Croisic. After some months of study to determine the elevation of the grounds and their nature, I arranged an experimental park on the shore, and I sought to imitate the method practiced along the shores of the Seudre. The claires which I had established at Sissable were placed in such a condition as to fit them to receive the water, each spring tide, during 10 to 12 hours or less. Situated on the eastern part of the Croisic, where the sea is never disturbed by heavy waves, was the ground which I had at my disposal, and under such conditions that the methods in use at Marennes and on the Tremblade could be put into operation.

I will not speak here of the results of these attempts. They have exceeded my expectations. The products grown at Sissable would seem to rival those of Marennes, and if they are not yet well known it is because the establishment where they are grown has not yet passed far beyond the experimental stage, having as yet yielded for consumption only from 100,000 to 150,000 oysters. The product will, besides, always be as limited as the grounds (parks) where they are reared.

Besides their other qualities, in which, as I have said, they approach those of Marennes, the oysters of Sissable acquire a higher degree of viridity than those grown in the claires on the Seudre. I therefore found myself in the presence of the problem of which I will treat in this notice, and which I determined to solve.

Like Gaillon, of whose researches I was ignorant at this time, as well as of the publication of M. P. Petit, which appeared after my observations, I remarked the relation which existed between the viridity of the claires and that of the oysters.

The material which coats the bottom of the claires forms a slimy, blackish green layer, and superficially has all the appearance of being composed of *Nostocaceæ*, an inferior group of Algæ, representatives of which are so frequently found at the bases of humid walls, in ditches, and marshy places. Upon microscopic examination, M. Bornet and myself recognized that this substance was composed of an alga belonging to an entirely different group, in fact, of diatoms, the innumerable fusiform frustules of which traversed the field of the microscope in all directions in a very lively manner. We also thought that we recognized this diatom as nearly allied to *Amphipleura* and *Navicula*. But finally, in order to have the determination made as exactly as possible, we submitted it to M. Grunow, the able Austrian algologist, who very willingly examined it, stating that it was a variety of his *Navicula fusiformis*, to which he had given the name of *ostrearia*. (Grunow; New Diatoms from Honduras, in Month. Mic. Journ., 1877, p. 178.)

EXPLANATION OF FIGURE 1.

Navicula fusiformis, var. *ostrearia*, Grunow.

Enlarged 330 times. (The densely stippled extremities of the frustules indicate the portions of the organism in which the blue vegetable pigment is contained.)

This diatom presents a singular peculiarity, first observed by M. de Brébisson, as we have already seen from the note cited from M. Petit,

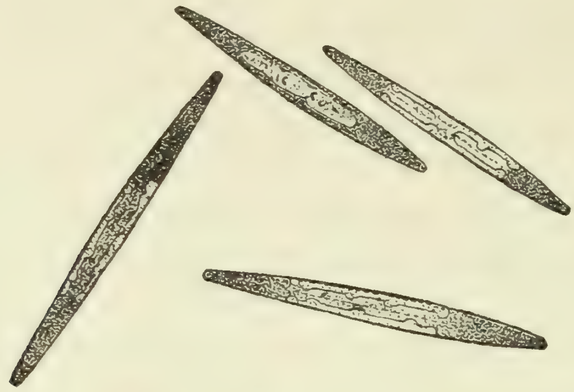

FIG. 1.

but which has not yet apparently been published by that savant. We know that the frustule of a diatom is a cell, the silicious wall of which incloses a yellowish pigment (diatomine), disposed, according to the germs, in the form of bands or granules, and a colorless liquid which fills up the rest of the cavity of the cell. For this reason when diatoms of the usual type are examined in mass they have a more or less intense yellowish brown color, but this is not the case with *Navicula ostrearia*. The two bands of chlorophylloid substance (diatomine) exist in this just as in all other *Naviculæ*, and they are of the usual yellowish color, but, aside from them, the intra cellular liquid, instead of being colorless, has a beautiful azure blue tint.

This tint is more pronounced at the extremities of the frustules than in the middle portion, where it is sometimes entirely absent. This substance belongs to the group of pigments, which are soluble in water, and is different from chlorophyll and diatomine, which do not dissolve in that liquid. Treated with water acidulated with acetic or hydrochloric acid, *Navicula ostrearia* immediately loses its blue color and the liquid absorbs the latter, becoming bluish-green. When dried this diatom also loses its color.

These facts being determined, the next experiment to be tried was plainly indicated. What result would we get if we took some white-fleshed oysters and fed them exclusively upon *Navicula ostrearia?* This we sought to determine in the following manner: Along the edges of a claire, which had become green, we very carefully collected with a spoon some of the green material with which the sides and bottom of the claire was coated. The material so collected in bottles was shaken for an instant so as to separate the heavy particles, and the dirt (which is almost impossible to get rid of entirely), is deposited on the bottom of the vessel; afterwards we poured off and saved the supernatant-colored liquid, which then contained nothing but the diatoms with the admixture of scarcely any foreign matters. We thus also obtained water, which was sufficiently charged with the necessary *naviculæ*. This operation requires some attention and some dexterity. When the diatoms have been

gathered with too great an amount of impurities or with too much water, which is nearly always the case when the duty of gathering them was intrusted to a guard, it is not always possible to have the mixture sufficiently concentrated or as clean as is to be desired.

Upon returning to our lodgings we poured the water charged with the diatoms into deep plates, which we placed on a table near a window. The diatoms soon collected on the sides and bottom of the vessels, in a greenish mucilaginous layer, the thickness and tint of which varied according to the richness of the gatherings. We then placed in each plate, according to the size of the latter, from three to six perfectly white-fleshed oysters, which had never been in a claire, the shells of which had also been previously washed and brushed clean. In similar plates, filled with ordinary sea water, we placed some oysters of the same kind as the others. In conducting this experiment we were of the opinion that the acquisition of the green color was altogether due to a peculiar regimen.

Twenty-six hours after the commencement of the experiment all of the oysters which had remained in the water charged with diatoms were deeply tinged with green; the others had not suffered any change of color. Repeated many times the experiment always gave the same result; the coloration was also more intense, or just in proportion as the water was more heavily charged with the diatoms. In one of our experiments an opening was made in the shell of one of the oysters so that the mantle of the mollusk could be seen from without. After having caused this oyster to become green we again placed it in pure sea water, and after some days the coloration had entirely disappeared. It reappeared when the oyster was replaced in some water containing *Navicula ostrearia*. This experiment was finally repeated at a distance from the scene of our work. White-fleshed oysters, which were sent to Paris, together with a flask containing water charged with the diatoms, were then fed and colored with them at the *Jardin des Plantes* in the laboratory of M. Decaisne.

In the course of the experiment we noticed that the oysters opened and closed their valves and caused currents to be established in the surrounding water, which were carried into the animal, together with the diatoms which they held in suspension. The existence and direction of these currents was apparent wherever the coating of diatoms was soon removed, thus leaving the bottom of the disk uncovered, but the covering of diatoms remained on those parts of the dishes where the action of the currents was not perceptible.

Carried to the buccal apparatus by the cilia with which the branchiæ are provided, the *Naviculæ* passed into the stomachs of the mollusks, where they give up their contained nutriment. The yellow chlorophyll is disintegrated and digested; the soluble pigment passes directly into the blood, to which it communicates its color. It is likewise the most vascular portions of the animal, such as the branchiæ, which are most deeply colored.

An examination of the digestive canal of the oysters used in the experiments proved that the soft substance of the diatoms was really absorbed. The stomach, intestine, and excrements were packed full of the tests of the *Naviculæ*. These tests, composed of silex, were not attacked by the juices of the stomach, but it would have astonished us to find that their contents, protected as they are by such a refractory envelope, had suffered dissolution by the action of the digestive fluids of the oyster, if we did not know that this envelope was not completely closed, but that there is an unsilicified line of suture which separates the two valves which compose the frustules of the diatoms.

There therefore remains no longer any doubt as to the fact that the viridity of oysters is entirely due to the absorption or digestion of the soft parts of the *Naviculæ* held in suspension by the surrounding water; this definite experience also completely overturns the hypotheses which attribute it to the influence of the soil, to the mixture of fresh and salt water, to northeast winds; in a word, all the other conjectural causes to which this simple phenomenon has been childishly attributed are shown to be inadequate.

It is evident, moreover, that the coloring matter is directly absorbed by the mollusks, and that the process takes place inside of the animals. If, in fact, dissolution of the coloring matter took place in sea water, the water would be tinged as soon as the diatoms were blanched. Now, this is not the case. In fresh water, on the contrary, the coloring matter is immediately dissolved and as a result the diatoms are blanched. A single drop of water placed on a slide containing the diatoms causes them to lose their color instantly. Finally, if a piece of filtering paper is saturated in the fresh water which has been placed on the diatoms, and it is afterwards dried, it will present absolutely the same color as the green oysters.

These laboratory observations are, moreover, perfectly in accord with the phenomena observed by the oyster culturists. Heavy rains cause the greenness of the claires to disappear, and the dry and salt-laden northeast winds, which augment the saturation of the waters, are, on the contrary, favorable to the production of the green coating in the claires.

If the subject is still far from exhausted, that part of it with which I have busied myself has been decided. Others who continue the research may, perhaps, do better than I, but not by the use of other methods. I submit these researches to my successors, and, without further comment, I would like to be permitted to call attention to the two following questions, which, it appears to me, it would be interesting to study:

1. Is *Navicula fusiformis* var. *ortrearia* present at all seasons of the year in the claires, or is it found in winter?

2. The coloration, which reveals its presence during the time when the claires are green, is it accidental and temporary? In other words,

does this alga disappear completely from the claires when the waters change their color, or does it only lose its color at this time?

These difficult questions which involve the consideration of the marvelous world of protophytes, require for their resolution much patient observation. But the difficulty of the problem only augmented the enjoyment of those engaged in its solution, and to conclude with an expression familiar to my sympathetic collaborator, I would say: we discovered all that we sought; that sufficed for the pleasure of the seeking.

SUPPLEMENTARY NOTE ON THE COLORATION OF THE BLOOD CORPUSCLES OF THE OYSTER.

By John A. Ryder.

The foregoing essay by M. Puységur has just recently fallen into my hands; earlier references which I made to his important investigations have been only at second hand and from notices which have not done his work justice. His methods have been positive, and there seems to have been little chance for him to have erred in his conclusions.

My own investigations of this subject have also convinced me of the correctness of M. Puységur's conclusions; they, in fact, supplement them. I subjoin a brief statement of the facts observed by me, together with some account of collateral observations by other investigators.

I have ascertained that *Ostrea virginica* is affected by an acquired viridity at certain times and in certain places in precisely the same way as the common *O. edulis* of Europe and the *O. angulata* of the Tagus, as I have been able to learn from fresh material from Liverpool, obtained for me through the efforts of Professor Baird. The cause of this peculiar staining of the soft parts of these animals is, therefore, very probably the same throughout both the European and the American oyster-growing regions. My own studies have also shown beyond a shadow of doubt that the acquisition of this color comes about as follows: That the coloring is either derived from without, or else may be a hepatic coloring principle, which, on account of some derangement of the normal metabolic processes of the animal, has been dissolved and absorbed by the lympho-hæmal fluids, and then imbibed by the blood cells or hæmatoblasts, and thus imparted to them their peculiar color. The blood cell of the oyster measures about $\frac{1}{3000}$th of an inch in diameter, but varies somewhat in size. It is amœbal in its behavior to a surprising degree, and throws out pseudopodia when at rest, which may even be branched. In a temperature abnormal to them in winter, that is, in a very warm room, I have had them live under a compressorium, bathed in the serum from the vessels of the animal, for four hours, dur-

ing which time they exhibited the most surprising activity of movement, at times even becoming confluent with one another.

The corpuscles which have been most deeply tinged appear to have lost their amœbal dispositions, and in this condition they tend to lodge in the numerous interstices between the prominent muscular trabeculæ found in the ventricle of the oyster. In a few instances I have found large cysts lying just below and covered by the epithelium of the mantle, which were packed full of these green-colored blood cells, which had apparently been accumulated in and been the cause of the formation of these cysts. When the cysts were cut open the corpuscles would very quickly escape, often in very feebly resistant masses, but which, upon shaking in a watch glass, would at once separate into distinct corpuscular bodies, each of which was provided with a nucleus. These corpuscles differed in no respect morphologically from a normal blood cell of the oyster, except in color.

The heart in oysters which are deeply tinged with green is often affected in its ventricular portion, where the deposit of corpuscles in the chinks between the trabeculæ of the ventricle and over the inner walls of the latter may be as much as a sixteenth of an inch in thickness. This thick deposit of green corpuscles gives to the normally somewhat translucent ventricle a delicate pea-green color. This condition of affairs may sometimes be well seen in sections of the heart of a green oyster, where the stratum of abnormal cells is thus shown to be present as a thick adherent layer covering the whole of the internal parietes of the ventricle, which even extends down behind the upwardly directed lips of the auriculo-ventricular valves, so as possibly to some extent impede their free action. Occasionally an impoverished green oyster may be found, the vessels of which exhibit this coloring faintly in their courses through the mantle.

The nature of this coloring matter seems to have been very satisfactorily determined by M. Puységur, who concludes, as we have seen, that it is neither chlorophyll nor diatomine, though he does not seem to have resorted to spectroscopic analysis and has relied entirely upon other physical tests, mainly such as would determine its solubility in various menstrua. He shows that it is some specific coloring matter which, unlike chlorophyll, is soluble in water. I would here suggest that it is probably a peculiar form of chlorophyll, allied to what is known as *phycocyanin*, which is found in certain simple algæ, known to botanists as the *Cyanophyceæ*, which embrace five subdivisions, viz, *Chroococceæ*, *Nostocaceæ*, *Oscillatorieæ*, *Rivularieæ*, and *Scytonemeæ*, according to Sachs, who says: "These organisms are of a bluish, emerald, or brownish green, or some similar color due to a mixture of true chlorophyll and phycocyanin; this pigment becomes diffused out of dead or ruptured cells, and thus produces the blue stain on the paper on which *Oscillatorieæ* are dried. From crushed specimens treated with cold water phycocyanin is extracted as a beautiful blue solution, blood red in reflected light (Cien-

kowski and Rostafinski). When the crushed plants are treated with strong alcohol, after the extraction of the blue pigment, a green solution is obtained, which contains true chlorophyll, and probably a special yellow pigment, phycoxanthin (Millardet and Kraus)." The group of phycocyan and phycoerythrine vegetable pigments, according to H. C. Sorby, give remarkable spectra with one main absorption band.

I have failed to prove by spectroscopic research that the substance which tinges the oyster is chlorophyll. In fact I have been unable to obtain alcoholic solutions of this substance from green oysters which were apparently dense enough to give a spectrum, and light, which had been transmitted through a mass of the green blood-cells, also failed to show any absorption bands. Dessication destroys the bluish-green color in *Navicula ostrearia*, according to Puységur, and it is significant in this connection that Sorby found that the Phycocyanin group of pigments were also associated with albuminous substances somewhat in the same way as hæmoglobin in the blood, being, like the latter, decomposed at exactly the same temperature as that at which albumen coagulates. My own view may therefore be expressed as follows: That the coloring material in green oysters, on account of its solubility in water, its instability and color, is probably allied to Phycocyanin, since we know that it is not chlorophyll, because the latter is insoluble in water, meanwhile remembering that the spectroscope also gave us entirely negative evidence upon this point.

The diffuse bluish coloring matters of *Stentor coeruleus* and *Freia* are also interesting in this connection. The detection of vegetable algous parasites in the fresh-water mussel by Leidy is a case of an entirely different nature, from the condition of things found in green-fleshed oysters, yet it is interesting as an illustration of animal and vegetable symbiosis.

The most searching tests which I made for the detection of the presence of green vegetable parasites in the oyster, as I at one time supposed, have given negative results, and I think that in the presence of all the foregoing evidence the phenomenon can be in no sense due to *symbiosis*, but rather to a tinging of the blood cells by an unstable coloring matter, which has been dissolved out of the food, and which in this case is derived from a diatom, in the more fluid plasma of which it exists in much the same relation to the latter as the hæmoglobin found in the blood corpuscles of vertebrates, or the coloring matters which tinge the blood of Cephalopods, or those of some of the *Arcidæ*, but not forming, as in them, a normal portion of their substance.

The coloring matter, however, in the case of the oyster when absorbed from its vegetable source produces certain abnormal changes in those blood-cells which imbibe it, as is conclusively shown by the facts which we have related regarding the accumulation of the tinged corpuscles in cysts of an abnormal character, as well as in the heart. Yet this effect is clearly unlike that produced by inert staining fluids, such as are used

in making histological preparations; for, as a rule, none of these will be absorbed until the tissue has been killed by some other re-agents, or not until the cells have been pricked open, so as to break the continuity of their walls, which are not immediately pervious to coloring agents. The fact also that the green color may be again gradually withdrawn by removing the food which is the cause of the viridity, is equally remarkable, and is likewise not a property of other staining fluids used to tinge dead cells, with the exception of some of the anilines, such as Safranin and Dahlia. Yet in this last case the parallel which has been instituted is again unfair, because the anilines are extracted from dead plasma, whereas the green color is withdrawn from the living plasma of the blood cells.

It is also evident that whatever the nature of the change may be which is induced by the green-coloring principle in the blood-cells of the oyster, that it does not interfere with the nutrition of the animal, which, according to the universal, concurrent testimony of oystermen, is almost invariably plump and in good condition when its soft parts have become greenish. This is also proof that the coloring material must be more inert than carmine, and must necessarily not be poisonous, or else the nutritive processes would be greatly interfered with, especially if the color were of mineral origin. For it is known that certain mineral substances have an extraordinarily high chemical equivalency when combined with protoplasm; some mineral salts, such as those of arsenic, lead, copper, and mercury, will enter into combination with many hundreds of times their own weight of living protoplasm; this circumstance seems to explain why these substances are so poisonous; why they produce violent symptoms in the process of elimination, or produce a fixed condition of the plasma and death.

Sometimes the flesh of oysters has a decidedly yellowish cast, verging to brownish-yellow in certain parts, especially the palps, gills, and edges of the mantle. This I have at times supposed to be due to the consumption of large quantities of the tests of diatoms, which were filled mostly with yellowish-brown endochrome or diatomine. If the peptones or ferments secreted by the gastric glands (the liver) of the oyster merely dissolve this material, I see no reason why, under certain circumstances, a pale brownish-yellow tint might not be assumed by the blood-cells of the animal after having absorbed that substance in the same way that they absorb the bluish-green tint. That the brownish endochrome might, in short, be carried in solution into the vessels and there imbibed by the blood-cells is very probable. That the siliceous tests of diatoms are quickly emptied of their plasma and endochrome after they are swallowed by mollusks is shown by the fact that I have never found a diatom in any part of the alimentary canal of the oyster, except the stomach, from which all the contents had not been removed.

Taking a survey of the lower groups of the vegetable world, which contain bluish-green pigments, and which are at the same time free-swimming in their habits, so as to place them within reach of the stationary oyster as food, there is none which actually seems more likely to be the source of the green tinge here discussed than the *Diatomaceæ.* And as there is no other class of forms so commonly and constantly met with in the alimentary canals of marine mollusks generally, I think we might take it for granted, for this reason alone, that they are the source of the coloration. In fact, it is rarely that I have met with any other vegetable organisms in the stomachs of oysters except diatoms, after having examined hundreds, by the excellent method of first removing the recently-swallowed contents of the gastric cavity with a pipette thrust into the mouth and through the short gullet. The "bill of fare" of the animal can then be very deliberately studied under the microscope after the contents of the pipette have been pressed out upon and prepared for observation under a compressorium. This method was also independently adopted by M. Certes in the course of his investigations upon the commensal fauna of the oyster, which led to the discovery of the remarkable organism which he has called *Trypanosoma Balbianii*, and which is almost as invariably present in the alimentary canal of the oyster as the frustules of diatomaceous plants. While the fact that diatoms impart a green tinge to oysters, which have been erroneously supposed to be hurtful in that condition when consumed as food, it is also very probably true that in the case of the common *Mya arenaria*, the flesh of which is said to occasionally acquire a greenish tint, the coloration is in like manner derived from the same source, viz, the diatomaceous plants.

APPENDIX E.

PROPAGATION OF FOOD-FISHES.

XXVII.—ACCOUNT OF EGGS REPACKED AND SHIPPED TO FOREIGN COUNTRIES, UNDER THE DIRECTION OF THE UNITED STATES FISH COMMISSION, DURING THE WINTER OF 1882-'83.

By Fred Mather.

GERMANY.

A. Brook trout, *S. fontinalis.*—December 29, 1882, I received from F. N. Clark, Northville, Mich., 25,000 eggs of brook trout. The box came on Friday, and the North German Lloyd steamer was to sail next day. I removed the sawdust packing and substituted ice and sent the box to Hoboken Saturday morning, but instead of sailing at the usual time, 2 p. m., the ship went at 9 a. m., and the box was too late. This package also contained the eggs of lake trout and whitefish. It was placed in a stable in Hoboken and iced frequently until the next week, when they were sent to the Deutsche Fischerei Verein, Berlin, care F. Busse, Geestemunde, on Saturday, January 6, 1883. They were received in Germany in good order, as the reports below will show.

On February 2, 1883, I received a second package of brook-trout eggs from Mr. Clark containing 20,000 brook-trout eggs, which were shipped by steamer Salier on the same day to the Deutsche Fischerei Verein.

B. Lake trout, *S. namaycush.*—December 29, 1882, received a box containing 100,000 eggs of the lake trout, which went on January 6, 1883, with the first lot of brook trout to the Deutsche Fischerei Verein. They were spilled from the package by some accident, and whether all were lost or not my advices do not say.

C. Whitefish, *Coregonus albus.*—December 29, 1882, I received from F. N. Clark, Northville, Mich., 10,000 eggs of the whitefish, which were sent on January 6 with the first lot of brook trout to Mr. G. Ebrecht, Geestemunde.

Received December 29 as above, and shipped January 6, 500,000 whitefish eggs to Deutsche Fischerei Verein, Berlin. Arrived there in good order.

D. Land-locked salmon, *Salmo salar var. Sebago.*—Received on March 3, 1883, 25,000 eggs of the land-locked salmon from Mr. Charles G. Atkins, Grand Lake Stream, Maine, and repacked and shipped by North German Lloyd steamer Neckar on March 10 to Deutsche Fischerei Verein.

I append the following from letter of Mr. Busse, agent of the Fischerei Verein, at Geestemunde, who received all the eggs from the ships. It includes all but the last shipment of land-locked salmon. The letter is dated Geestemunde, 24th of February, 1883:

"In due reply to your very esteemed favor of the 5th instant, I beg leave to inform you that all the fish eggs you sent through my hands to me for the Deutsche Fischerei Verein, Berlin, have arrived here in a proper and sound condition. Only the lake trout did not come in well, for most of them had slipped out before reaching me. As to the eggs Mr. Ebrecht received from you, I am sorry that I cannot tell you anything about them, as I have not seen the lot. No doubt they will have been in the same good condition."

FRANCE.

A. BROOK TROUT.—February 2, 1883, received 20,000 eggs of brook trout from F. N. Clark, Northville, Mich., and repacked and shipped them to the Société d'Acclimatation, Paris, care M. Raveret Wattel, secretary, by the steamer St. Laurent of the General Transatlantic Company, on February 6. They arrived in good order in France.

B. LAKE TROUT.—January 2, 1883, received from Mr. Clark 50,000 lake-trout eggs, which I repacked and sent on the steamer Labrador, of the General Transatlantic Company, to the Société d'Acclimatation, Paris, January 3. They arrived in France in good condition.

C. WHITEFISH.—December 29, 1882, received 200,000 whitefish eggs from Mr. Clark, and repacked and shipped them to the Société d'Acclimatation, Paris, January 3, 1883, by steamer Labrador, of the General Transatlantic Company. They arrived in France in good condition.

D. LAND-LOCKED SALMON.—March 3, 1883, received from Mr. Atkins 15,000 eggs of the land-locked salmon, and repacked and shipped them to the Société d'Acclimatation, Paris, by steamer Canada, of the General Transatlantic Company, on March 7. In this connection I would refer to the following, from letters dated Paris, February 8, March 3, and March 31:

"I have received in perfect condition the eggs of *Salmo namaycush* and *Coregonus albus* that you have had the kindness to forward to our society, and I trust there will be a good result."

"We have received in most splendid condition the trout eggs (*S. fontinalis*) that you have had the kindness to forward us, from Professor Baird. They were packed up in so perfect condition that not one had been lost, and I consider it as a certainty that they will give a lively fry. So it is a new success."

To Professor Baird he writes:

"I have received in perfect condition the ova of land-locked salmon forwarded to our society, under your kind direction, by Mr. Mather. They were really splendid as for the preservation, and not one had

been lost. The model of package was better again than the former. Permit me to express to you all our thanks for this new present, and to assure you of our deep gratitude."

ENGLAND.

A. Brook trout.—On February 2 I received 10,000 eggs of brook trout from Mr. F. N. Clark, Northville, Mich., and repacked them and sent by Cunard steamer Catalonia to the Norfolk and Suffolk Acclimatization Society, care Hon. W. Oldham Chambers, secretary, Lowestoft.

I will refer for their condition to the following letter, dated Norfolk and Suffolk Fish Acclimatization Society, honorable secretary's office, Lowestoft, February 26, 1883:

"I have pleasure in reporting to you that the 10,000 *S. fontinalis* eggs arrived from New York in grand condition. I do not think I have picked out more than 50 dead eggs in all. I must certainly congratulate you upon the most successful system you have adopted in packing eggs for transit. If you possibly can spare a few land-locked salmon eggs for my society we shall be particularly indebted. It is not a large quantity that I ask for; we so much want to get this particular strain of salmon in our waters, fully believing they will form a very valuable addition to the food-fishes of England. Your best endeavors in this direction will be particularly esteemed. I have written to the Hon. Spencer Baird by this post, thanking him for the handsome donation of fontinalis eggs."

B. Land-locked salmon.—On March 3, 1883, I received 10,000 eggs of the land-locked salmon from Mr. C. G. Atkins, and shipped them by Cunard steamer Bothnia to the Norfolk and Suffolk Acclimatization Society, care of Mr. Chambers, Lowestoft, on March 7.

The following report of their condition is taken from a letter to Professor Baird, dated Lowestoft, April 6, 1883:

"I have much pleasure in reporting to you the safe arrival of 10,000 land-locked salmon eggs, which were duly received at my hatchery on the 19th of last month. My executive committee desire me to express to you their thanks for this generous gift and practical desire on your part to increase the food-fishes of this country. I am happy to say the *S. fontinalis* eggs have hatched off with only a nominal loss."

SOUTH AMERICA.

A. Brook trout.—On January 9, 1883, I repacked for Mr. E. G. Blackford, Fulton Market, New York, 6,000 eggs of the brook trout, being part of 10,000 of the same which he had received from Mr. F. N. Clark, Northville, Mich., for shipment, in charge of Mr. Ricardo Becerra, Bogota. The remainder of the eggs were kept in a jar and hatched in Fulton Market. I have no advices as to the condition of the eggs on their arrival at their destination.

BLACK BASS.

In August, 1882, I went to Greenwood Lake, lying partly in New York and partly in New Jersey, and took some medium-sized small-mouthed black bass with the artificial fly, and some small bass of the big-mouthed species with bait. The former were fish of a half pound to one pound in weight. They were placed in the tanks of Mr. E. G. Blackford, Fulton Market, New York, and kept there all summer. About the middle of February Mr. George Eckardt sailed in the North German Lloyd steamer Elbe with what was left of them. The following letter from Max von dem Borne acknowledges their safe arrival. It is dated Berneuchen, March 3, 1883, and is as follows: "The black bass arrived safely on February 27 in Bremen, and reached Berneuchen March 3. Allow me to thank you very much for so much trouble you have so kindly taken in this matter. There were seven large and forty-four small black bass, and one small perch. Is this the number you gave to Mr. Eckardt? I should be extremely obliged to you if you would kindly inform me how I am to breed these fish, whether in pond that can be drained, or by artificial incubation. How deep should be the ponds? Should the bottom be rocky, gravelly, sandy, or muddy? Perhaps you would reply to these questions in Forest and Stream? In about a fortnight I hope to send you on my own account (not in behalf of the Deutsche Fischerei Verein) 10,000 eggs of our brook trout, which is foreign in America."

I also assisted Mr. Silk in procuring some black bass in October for England. They also arrived in safety and were placed in the ponds of the Marquis of Exeter.

XXVIII.—REPORT OF OPERATIONS AT THE NORTHVILLE AND ALPENA (MICH.) STATIONS, FOR THE SEASON OF 1882-'83.

By Frank N. Clark.

The season just closed was a favorable one for the work of this department, and to this circumstance is due, in part, the fact that the volume of results more than double those of any previous corresponding period. The principal feature of the season's work was the propagation of whitefish, and this service was conducted on a very largely increased scale of operations as contemplated at the outset. In order to provide increased hatching and storage facilities, a new station was established at Alpena, Mich., a hatchery being built and equipped expressly for the treatment of eggs of whitefish. About 42,000,000 eggs were safely laid in at this point, during the month of November, resulting in the hatching of over 32,000,000 minnows the following spring, nearly all of which were planted in the great lakes.

At the Northville hatchery, about 30,000,000 whitefish eggs were received, principally from Lake Erie fisheries; from these nearly 12,000,000 eggs were shipped, and 16,000,000 minnows hatched and deposited in the great lakes. Other varieties of eggs were handled at Northville, as follows: 277,000 lake trout from Lake Huron fisheries; 473,000 brook trout from the stock of breeders held at the Northville ponds; 7,000 rainbow trout, also from the Northville ponds; 1,400 German trout, shipped to this station through favor of Mr. Fred. Mather; and 20,000 land-locked salmon transferred from Grand Lake Stream, Maine. Some 1,500 German carp from the national carp-ponds at Washington were distributed in lots of twenty, to applicants from various Northwestern States. Two new fish-ponds, one 10 by 60 feet, and the other 10 by 83, were added to the plant of the Northville station; and another pond, 30 by 100, designed for carp or bass propagation, was in process of construction at the close of the season.

The general plan of operations in the collection and manipulation of the eggs and treatment of the minnows varies but little from the methods of the preceding season, and need not, therefore, be dwelt upon at length. A more detailed statement of the results of the work, together with a few random notes and suggestions, directly or indirectly relating thereto, may, however, be worthy of record.

Alpena, where the new hatching station for whitefish was recently

established, is a rapidly growing city of nearly 10,000 inhabitants, situated at the head of Thunder Bay, an indenture of western Lake Huron. Its chief exports are the products of the adjacent forests and of the fisheries. Although having no railroad facilities, the Thunder Bay River affords a fine harbor, capable of receiving the largest lake craft; first class and frequent boat service is therefore supplied during the season of navigation. Although no fishing-grounds of any account are found within a radius of 15 miles of the mouth of the river, Alpena is the natural center for the fishing interests of a considerable section. Indeed, the products, not only of the Thunder Bay fisheries, but of the shore fisheries for miles above and below, are compelled to go there to find prompt and satisfactory shipping service, as it is the only first-class harbor in that region. The principal fishing-grounds are the island shoals, the shoals near the mouth of the bay, the shore grounds above and below, and the "big reef," a stretch of comparatively shoal grounds out in the lake about 45 to 50 miles nearly due east from the mouth of the river. These islands, as in many cases is the case with the immediate base of operations along the main-land, are mere rocky or sandy wastes, uninhabited except during the fishing season by the sailing-craft fishermen, who find it impossible to handle their nets daily and port at Alpena, 15 to 25 miles away. Special sailers or tugs are employed to make daily or tri-weekly visits to these points to collect the fish and carry them in. Trap or pound nets are the apparatus usually employed off the islands and along the shore, though many small gill-net boats run to these grounds during the best of the spawning season. By far the most extensive gill-net operations are conducted by the fishing tugs that port at Alpena, and make daily trips, weather permitting, to the shoals near the mouth of the bay or to the "big reef" outside. Fishing at the latter point is a very laborious occupation, as the nets are set in water many fathoms deeper than is found over the inner shoals, and, being so far out, there is usually more or less sea, even with leeward winds prevailing. Moreover, the crews are employed in favorable weather sixteen to eighteen hours out of twenty-four. The boats steam out of harbor about 2 a. m., arriving at the grounds at daylight; the work of lifting and resetting the nets then goes on until 4 or 5 o'clock in the afternoon, the time of the return trip being occupied in cutting and cleaning the fish, unless a heavy sea and pitching of the boat prevents, in which case this work is done by the same crew upon arrival at shore.

Whitefish and lake trout comprise the principal varieties of fish brought to Alpena, though there is a sprinkling of wall-eyed pike, and some few herring. The trout and whitefish seldom mingle to any extent, though schools of each may run to the same grounds at different times. Whitefish, however, are seldom caught from the "big reef" grounds—nothing but trout.

The methods of preparing the fish for shipment depend largely on

the weather and their condition when brought in; but they are usually either frozen in shallow pans, or dressed (the entrails removed), washed and packed in ice in fish cars holding from 1,000 to 2,500 pounds each. The cars are then shipped by steamer, in the refrigerator apartment, with which some of the vessels plying between Detroit and Lake Huron ports are supplied, especially for the accommodation of this trade. The cakes of frozen fish from the pans, packed in boxes of a convenient size for handling, are also shipped in the vessel's refrigerator. But few fish are salted; nearly everything is shipped fresh to the real base of operations at Detroit, and stored in large refrigerators to meet the demand of the local and other markets for fresh fish.

The capital required to operate these fresh water fisheries on a large scale will not, of course, compare with the requirements of the large ocean fisheries; still, there are several firms interested in the business on Lake Huron, with headquarters at Detroit, whose investments in fish-tugs, fish-cars, nets, refrigerators, ice and store houses, etc., will exceed $100,000 each.

There is a noticeable difference between the spawning runs of whitefish of the island region of Lake Erie and the Thunder Bay region of Lake Huron, both in the fish themselves and their movements. The former include but one variety, while the latter are represented by two distinct types, each running to different grounds at different times. One of these runs, composed of fish nearly identical in appearance with the Lake Erie fish, though a little larger and coarser, sets in along the shore from Oscoda to Alcona and Scarecrow Island; the other, the dark-green-backed variety, follows about a week later on the shoals near the mouth of the bay. The run of spawning-fish to the Lake Erie islands is a steady flow, lasting, usually, from 25 to 35 days, the daily average being much lighter than at some of the Lake Huron grounds, but much better sustained. At Thunder Bay and the shore grounds approaching thereto the spawners suddenly appear in vast schools, the run lasting about a week, then dropping away quite as suddenly as they appeared.

THE ALPENA HATCHERY.

This hatchery was built, equipped, and filled with eggs under the immediate supervision of my chief assistant, Mr. S. Bower, and subsequently superintended by Mr. S. P. Wires, a former employé of the Northville hatchery. I repeat the following description of the Alpena hatchery, written for the London exhibition:

"This hatchery was built in the fall of 1882. It is a one-story frame building, 30 feet wide by 60 feet long, having front and rear entrances, and amply lighted by fourteen windows. The main floor includes the hatching-room and an office and sleeping apartment 10 feet wide by 18 long. The space between the office and the opposite side is conveniently utilized for storage of tools, cans, egg cases, etc. The hatchery

is arranged and equipped with especial reference to the manipulation of the embryos and minnows of whitefish (*Coregonus clupeiformis*), the most valuable commercial species of the great lakes. Its nominal capacity is 100,000,000 eggs.

"The water is furnished by the Alpena Water Company of Alpena, being forced through wooden mains from Thunder Bay, an arm of Lake Huron. A 2-inch stream, under an average pressure of 20 pounds to the square inch, connects with the hatchery, the discharge being regulated by globe valves. The inlet pipe is laid underneath the building, near the front, and is tapped by four perpendicular arms, each discharging into the top tank of one of the four systems of tanks for supplying water to the hatching apparatus. Each system comprises a series of four rows of tanks, one row above the other. There are two tanks to each row, making eight tanks in the series, or thirty-two in all, each of which is 15 feet long by 12 inches wide and 10 inches deep. One series is the exact counterpart of another. A row of faucets on either side of the top tank, into which the water first enters, supplies two rows of hatching-jars, or incubators, which stand on shelves placed across the second tank below and discharge into the tank between, which, in turn, feeds a second series of jars, and so on. In this way the four rows of a series operate three double rows of jars, the water being used three times over. Overflows are provided at the ends of the tanks, which discharge into the next below.

"Each of these series of reservoirs is connected with larger tanks, into which the minnows are carried by the current as soon as hatched.

"The outflow openings of the tanks for the reception and storage of the minnows are protected by finely perforated tin boxes of sufficient dimensions to keep the little fish away from the vortex formed by the escaping fluid, where they would be liable to injury from the strong current. There are ten of these receiving tanks, with an aggregate capacity of 7,000 gallons."

Work on the building was begun October 1, and pushed rapidly forward to completion. The inside work was completed and jars placed in position in time for the first arrival of eggs, November 10. It should be stated that, although the capacity of the hatchery is 100,000,000 eggs, a partial equipment was decided on for its first season, in accordance with which only two hundred and eight jars were ordered and received.

The water is furnished free of cost by the company above referred to, which derives its supply, for ordinary purposes, through pipes tapping the bay a considerable distance above the city, where it is always perfectly clear and pure. Another inlet main, however, is laid to the river, just above the city limits; but this, fortunately, is opened only in case of fire. This water is generally murky with sediment and impurities, as the river is the vehicle for floating down vast numbers of logs from the pineries in the interior. Four fires occurred the past win-

ter while eggs were in the house, and though the influx of moss and sediment occasioned no loss of eggs, the greatest vigilance was demanded on each occasion to keep the faucets open and jars in operation. It was quite impossible to keep the flannel filters open, so they had to be removed until the influence of the river flushing had ceased to be felt. A repetition of this annoying feature is, however, hardly probable for more than another season, as the complaints of consumers and the increased consumption consequent upon a rapidly increasing population, must soon compel the company to increase their inlet capacity from the clear waters of the bay sufficient to meet the demands of all occasions.

Although the water company furnished water free of charge, and, in common with the citizens of Alpena, lent every encouragement to the work of the past season, it is possible that they may protest against granting further supplies on this basis when the work shall have been largely increased. In order, therefore, to insure a continuance of the present terms and relations with the company, I would recommend an early introduction of the McDonald system of hatchers, by which at least three times the hatching capacity of the apparatus now in use can be obtained with the same volume of water.

At the Northville station the question of water-power grows more and more important with each succeeding season, as the work increases. Although operations at the hatchery have not hitherto been sufficiently extensive to consume the entire flow from the supplying springs, the limit will soon be reached at the present rate of growth of the work, unless the apparatus now employed be supplanted by some system which shall include the McDonald repeating principle. Any system that combines maximum of capacity with minimum of water-power is, moreover, especially valuable for hatcheries supplied with spring water, which has first to be reduced in temperature by artificial processes or exposure.

PENNING WHITEFISH.

Our whitefish eggs were obtained, as usual, from the ripe fish found in the nets of the fishermen, men being sent out to take the eggs on the spot. While this plan is quite satisfactory under the most favorable circumstances, it is not very reliable, owing to the uncertainties of the weather at this season of the year. Moreover, the opportunities for getting eggs must, at the very best, be restricted to a narrow contingent, as it is well understood that not one fish out of a dozen is fit for use when caught, the rest being either unripe or spent. It is, therefore, important to note that experiments at the Northville hatchery, as well as at the Detroit hatchery of the Michigan commission, have demonstrated the perfect feasibility of holding the immature spawners in confinement until every egg has been secured, thus making it possible to save the entire crop of eggs not deposited by the fish themselves. The most of the stock of eggs at the Detroit hatchery the past season was obtained

in this way; and the very best eggs at the Northville hatchery were taken from fish brought from Lake Erie in casks and held in tanks in the hatchery from six to seventeen days, until they had matured. The high quality of the eggs in this particular instance may be credited to the fact that they could be taken with much greater care than is possible in the hurry and confusion of pound-net operations, and could be transferred at once to the hatching jars. For the approaching season we hope to apply this principle on a large scale for filling both the Alpena and Northville houses. Having found a suitable depth of pure water in some harbor, the immature fish can be conveyed thence from the fisheries in casks or tanks and held in pens, pools, or floating tanks until all have ripened.

THE LAKE TROUT WORK.

The lake-trout eggs brought forward at the Northville hatchery were obtained in the vicinity of Alpena, from fish taken in gill-nets set on the "big reef" and along the shoals at the mouth of the bay. Most of the eggs were taken by Mr. Wires, an expert, who at the same time initiated a force of men into the business, in order to be prepared for the collection of whitefish eggs, which was soon to follow on a much larger scale.

The weather was rather too warm at this time for shipping eggs. which accounts for the poor condition in which some of the cases arrived at Northville. Another season we hope to make a much better showing in quantity as well as quality. Plenty of experienced help can be obtained near the fisheries, and we now have a hatchery near by, in which the eggs can be stored until colder weather before shipping.

In all 277,000 of the lake-trout eggs were taken, as follows: October 18th, 5,000; 21st, 10,000; 23d, 12,500; 24th, 15,000; 27th, 37,500; 28th, 12,500; 30th, 32,500; November 3d, 50,000; 4th, 62,000, and 8th, 40,000.

The day the last trout eggs were taken (November 8) two ripe whitefish were brought in from the Partridge Point fisheries; the men were, therefore, transferred at once to whitefish operations.

Shipments of lake-trout eggs were made from Northville, as follows: November 26th, 50,000 to the central station at Washington, D. C.; December 27th, 100,000 to Fred. Mather, Newark, N. J., for reshipment to von Behr, Germany; December 30th, 50,000 to Fred. Mather, for the Société d'Acclimatation, Paris, France; and 3,000 (January 27th) to Fred. Mather for hatchery at Cold Spring Harbor, Long Island.

GERMAN TROUT.

Through favor of Messrs. Mather and Blackford some 5,000 trout eggs from Germany (species not stated) were shipped to Northville, arriving March 26. The eggs were so far advanced when shipped that about three-fourths of them hatched on the way; the remainder, in good condition, were placed at once in hatching-boxes and hatched in a few

days. The fry were treated the same as our native trout, but did not eat so readily at first, about one-fourth of them dying soon after the absorption of the umbilical sac, the most critical period of trout raising. Such, however, as commenced at once to take food have done very well, indeed, and are at the present writing (September 1) quite as large as the native trout of the same age.

RAINBOW TROUT.

In this connection I am compelled to record the first serious failure in the history of the Northville establishment. Our facilities being first-class, and having been uniformly successful in the propagation of trout, not excepting the preliminary experiments with rainbow trout for four seasons, I had confidently expected to embryonize from one to two hundred thousand eggs from the stock of *irideus* hatched and grown at this station; but we succeeded in getting only about 45,000 eggs (many of the females failing to mature their spawn), and in fertilizing but 15 per cent. of these, resulting in a hatch of 6,400 fish. The parent fish of both sexes were, and still are, perfectly normal, so far as conduct and appearances would indicate. The trouble, however, seems to have been entirely with the females, as the quantity and quality of the male principle was all that could be desired. Whatever the cause of the difficulty the effect was at once apparent in the abnormal character of the fluid surrounding the eggs. From most of the females the eggs would fall into the receiving pan like shot, accompanied by ½ to 1 fluid ounce of a watery substance, sufficient of which had been absorbed to prevent fertilization. If there was any doubt that absorption of water by a large percentage of the eggs had taken place before leaving the fish, it was dispelled by the fact that they were quite full and hard when taken and refused afterwards to take up more water. Moreover, the eggs from six females were found enveloped in the natural viscous fluid, and these were successfully fecundated.

Without attempting to account for the failure, I am inclined to think that the fish were overfed, and that the inflow to their pond gave them a current quite too slow and feeble, resulting for the most part in great inactivity and in their being in good condition for market at spawning time. As an experiment I propose to reduce their food allowance to the minimum, and place them in a good current of water in one of the long, narrow ponds lately constructed, the *irideus* being particularly fond of rapids and swift currents.

In appearance these eggs were almost identical with those of the *salvelinus*, being about the same size and fully as light colored. Though the most of them were a total loss, those that were fertilized produced exceedingly vigorous fry, which have since grown so rapidly that they are now larger than any of the species of same age heretofore grown at the hatchery.

The following table may be of value as showing the time of spawn-

ing, and the great variance of yield from fish of same age, all being three years old, with the exceptions noted. The eggs were counted at the rate of 400 to the fluid ounce, the accuracy of this standard having been determined by actual count:

Date eggs were taken.	Number females spawned.	Number eggs obtained.	Remarks.
1883.			
Feb. 13	2	2,400	
Feb. 14	1	300	Partly spent.
Feb. 15	6	4,800	One partly spent.
Feb. 16	3	1,100	
Feb. 19	4	2,575	
Feb. 20	5	3,250	6 ounces of water from the 5 fish.
Feb. 21	2	1,200	1 nearly spent.
Feb. 24	1	1,000	
Feb. 25	1	600	
Feb. 28	2	1,600	
Mar. 2	4	3,100	1 5 year-old.
Mar. 4	1	600	
Mar. 5	1	600	
Mar. 6	1	600	
Mar. 10	1	600	Partly spent.
Mar. 11	2	1,100	
Mar. 13	3	900	
Mar. 15	3	2,500	
Mar. 16	4	1,850	2 nearly spent.
Mar. 17	2	2,000	1 5-year old; eggs more highly colored.
Mar. 18	1	1,200	
Mar. 22	2	1,500	
Mar. 29	1	500	
Mar. 30	2	1,400	
Mar. 31	1	2,375	Large 5-year old; eggs all impregnated.
Apr. 2	1	1,000	
Apr. 6	1	300	
Apr. 9	2	3,000	1 5-year old; eggs in good condition.
Apr. 10	6	800	
Apr. 14	1	100	Nearly spent.
Apr. 19	1	300	
Total	68	45,150	

LAND-LOCKED SALMON.

A case of 20,000 eggs of this species was shipped to the station from Grand Lake Stream, Maine, arriving March 12 in most excellent condition. The loss while in the hatching boxes was very trifling, being less, in fact, than the subsequent loss of fish in the nursery tanks. The fry were disposed of as follows: May 28, delivered to Messrs. E. K. Simonds and A. M. Randolph 10,000, of which 8,000 were planted in Union Lake, Oakland County, and the remainder in Cooley Lake, same county; June 13, delivered 7,000 to same parties, who planted them all in Union Lake; June 14, delivered the remaining fry, about 1,800, to the Michigan Fish Commission. Total results, 18,800 fry.

Union Lake is a fair type of the many beautiful inland lakes dotting Oakland, and many other counties of the Lower Peninsula. It is about 8 miles in circumference, is deep and clear, and is fed principally by springs from the bottom, having no inlet except a small stream from Green Lake, near by, which has no visible inlet. A good plant of land-locked salmon was made in Union Lake last year, and this with the

recent liberal plants will, I have every reason to believe, permanently establish the species in these waters. The experiment is not without a successful precedent, the species having already been introduced and acclimatized, in this way, in waters of the same character in Kalkaska County, this State. Quite a number of adult specimens were taken from the waters referred to during the past year.

BROOK TROUT.

Our brook trout work was, on the whole, quite satisfactory. In all, 473,000 eggs were obtained, from which 357,000 eggs were shipped, and 50,000 fry hatched. Of the latter, 15,000 were delivered to the Ohio Fish Commission, April 10; the remainder were on hand at the hatchery at the close of the period covered by this report, though a few small shipments have since been made.

Between twenty and twenty-five thousand eggs were obtained from wild trout running up the waste stream from the ponds, which forms a natural raceway connecting with a branch of the River Rouge, a small stream well stocked with trout. Over 300 of these fish, of various sizes, and mostly males, were captured.

From the tables which follow it will be seen that 97,150 eggs were obtained from 422 spawners, 20 months old, an average of 230 eggs each; 184,660 eggs from 274 spawners, 30 months old, an average of 674; 168,700 eggs from 120 spawners, 42 and 54 months old and upwards, an average of 1,406; and 22,500 from 43 wild trout, an average of 524.

Eggs were shipped as follows:

Date.	Number.	Consignee.	Remarks.
1882.			
Nov. 26	50,000	Central hatching station, Washington, D. C.	Shipped in United States Fish Commission car No. 1; arrived in good condition.
Dec. 27	25,000	Fred Mather, Newark, N. J	Arrived in good condition and reshipped to Herr von Behr, Germany.
1883.			
Jan. 9	10,000	E. G. Blackford, Fulton Market, New York.	Arrived in fair condition and reshipped to Bogota, South America.
26	50,000	Fred Mather, Cold Spring Harbor, New York.	Arrived in good condition.
27	50,000	Fred Mather, Cold Spring Harbor, New York.	Arrived in good condition.
29	50,000	Fred Mather, Cold Spring Harbor, New York.	Arrived in good condition.
31	20,000	Fred Mather, Newark, N. J	Arrived in good condition and reshipped to the Deutsche Fischerei Verein, Berlin.
31	20,000	Fred Mather, Newark, N. J	Arrived in good condition and reshipped to Société d'Acclimatation, Paris.
31	10,000	Fred Mather, Newark, N. J	Arrived in good condition and reshipped to Mr. W. Oldham Chambers, England.
Feb. 3	72,000	Central hatching station, Washington, D. C.	Arrived in good condition.
	357,000		

Mr. Mather reports that the shipments to Germany, France, and England arrived in first-class order.

Below are the tables of brook-trout eggs obtained, showing the daily results for the spawning season:

From trout forty-two and fifty-four months old and upwards.

Date.	Females spawned.	Eggs obtained.	Date.	Females spawned.	Eggs obtained.	Date.	Females spawned.	Eggs obtained.	Date.	Females spawned.	Eggs obtained.
1882.			1882.			1882.			1882.		
Oct. 26	1	2,000	Nov. 13	2	2,000	Nov. 24	3	3,800	Dec. 9	1	900
Nov. 2	1	1,000	14	6	9,000	25	2	2,200	10	1	1,100
3	2	2,400	15	3	2,400	26	4	5,200	12	2	2,900
4	1	1,300	16	5	10,000	27	2	3,600	15	2	2,400
5	1	1,500	17	5	7,200	28	3	3,200	18	1	1,200
7	5	8,200	18	2	3,300	29	5	5,600	19	1	800
8	3	5,100	19	1	1,100	30	1	1,200	21	1	900
9	4	4,800	20	5	6,400	Dec. 1	2	3,000	29	1	1,300
10	2	2,100	21	4	4,800	2	3	5,800	30	1	800
11	6	9,500	22	7	8,500	3	4	5,600			
12	5	8,700	23	5	10,500	4	4	5,400	Totals.	120	168,700

From trout thirty months old.

Date.	Females spawned.	Eggs obtained.	Date.	Females spawned.	Eggs obtained.	Date.	Females spawned.	Eggs obtained.	Date.	Females spawned.	Eggs obtained.
1882.			1882.			1882.			1882.		
Oct. 29	1	410	Nov. 14	3	1,700	Nov. 30	6	5,200	Dec. 16	1	500
30	1	350	15	6	3,800	Dec. 1	3	3,000	17	2	1,100
31	2	1,400	16	20	13,400	2	14	8,800	18	5	3,200
Nov. 1	2	1,100	17	14	8,600	3	4	2,600	20	2	1,000
3	6	3,100	19	2	1,000	4	4	4,200	21	4	4,100
4	2	950	20	5	3,950	5	3	2,500	22	3	2,700
5	1	450	21	9	5,800	6	2	2,000	25	2	800
6	8	3,900	22	5	4,400	8	1	900	26	1	850
7	1	500	23	7	6,600	9	2	800	27	4	2,600
8	9	3,700	24	3	1,600	10	5	4,400	28	1	900
9	13	7,800	25	3	2,100	11	1	700	29	1	1,100
10	11	4,700	26	12	8,100	12	4	4,200	30	1	550
11	6	3,050	27	6	3,700	13	6	5,400			
12	9	1,700	28	8	7,600	14	1	1,300	Totals.	274	184,660
13	3	1,100	29	6	5,500	15	7	7,200			

From trout twenty months old and from the wild trout.

Twenty months old.						Wild trout.					
Date.	Females spawned.	Eggs obtained.	Date.	Females spawned.	Eggs obtained.	Date.	Females spawned.	Eggs obtained.	Date.	Females spawned.	Eggs obtained.
1882.			1882.			1882.			1882.		
Nov. 2	15	2,000	Nov. 15	5	1,200	Oct. 17	1	200	Nov. 2	8	6,200
5	1	200	16	3	400	18	2	450	3	1	350
6	3	600	17	60	14,000	19	1	300	5	2	550
7	28	6,000	20	50	13,000	22	2	1,800	6	4	1,200
9	25	5,500	24	48	11,000	23	1	1,200	10	1	250
10	1	250	28	32	7,000	24	1	500	12	2	650
11	62	14,000				25	1	300	17	4	1,800
13	24	6,000	Totals.	422	97,150	26	2	750	18	1	300
14	65	16,000				29	3	1,500			
						31	0	1,80	Totals.	43	22,500
						Nov. 1	4	2,400			

THE WHITEFISH WORK.

At Northville the first lot of whitefish eggs was received November 16 and the last December 8. The first eggs were taken at North Bass Island, Lake Erie, November 11, and the last at the same place, December 7. With the exception of a small lot furnished by Alpena after the hatchery there was filled, the Northville supply was obtained wholly from fisheries at North Bass, Middle Bass, and Put-in Bay Islands, Lake Erie. The total receipts at Northville from all sources amounted to 30,200,000. Some three or four million of these arrived after the hatching jars were all filled; but they were very successfully carried forward in the shipping cases, at a temperature of 32° to 35°, until shipments and losses in the jars had made room for them. The eggs began hatching February 20, and completed April 1; average period of incubation, 106 days.

The water temperature varied from 32° to 54°, averaging about 40¾°.

At Alpena, the first eggs were taken November 10 and the last November 27, chiefly, however, from the 12th to the 20th. Most of the supply came from the pound-net fisheries at Scarecrow Island and Alcona and the gill-nets of the tug Wayne Isbell, which was fishing on the shoals at the mouth of the bay, though eggs were obtained from the tugs Minna, Lida, and McKinnon, and the fisheries at Oscoda, Ossineke, North Point, Misery Bay, Sugar Island, and Partridge Point.

The water temperature was quite high—50° to 55°—when the first eggs arrived, but soon went down below 40°, and remained uniformly low throughout the season, the average being about 35°. The eggs began hatching April 8, and all were out May 16. Average period of incubation, 160 days.

Eggs were shipped from Northville, as per the following table:

Date.	Number of eggs.	Consignee.	Remarks.
1882.			
Nov. 26	1,000,000	Central hatching station, Washington, D. C.	Shipped by United States Fish Commission car No. 1, in charge of G. H. H. Moore.
Dec. 27	50,000	Thomas Hughlett, Druid Hill hatchery, Baltimore, Md.	Arrived in good order; loss, 748 eggs.
27	100,000	Thomas Hughlett, Easton, Md....	Arrived in good order; loss, 48 eggs.
27	500,000	Fred Mather, Newark, N. J.......	Arrived in good condition, and forwarded to the Deutsche Fischerei Verein, Berlin, arriving there in excellent condition.
27	200,000	......do............................	Arrived in good condition, and forwarded to the Société d'Acclimatation, Paris, arriving there in excellent condition.
27	10,000	......do............................	Received in good order and forwarded to G. Ebrecht, Geestemunde, Germany. Not heard from.
28	1,000,000	R. O. Sweeny, Saint Paul, Minn.	Arrived in "most excellent condition."
30	1,000,000	......do............................	Do.
1883.			
Jan. 1	250,000	S. R. Throckmorton, San Leandro, Cal.	Not heard from.
3	200,000	E. B. Hodge, Plymouth, N. H....	Arrived in good order and placed in water of a temperature of 33° to 34°; hatched April 15 to 17; planted April 19; 193,000 in Newfound Lake, Grafton County, New Hampshire.
8	1,000,000	R. O. Sweeny, Saint Paul, Minn..	Received in good condition; loss very small.
9	250,000	S. R. Throckmorton, San Leandro, Cal.	Not heard from.

Date.		Number of eggs.	Consignee.	Remarks.
1883.				
Jan.	10	250,000	S. G. Worth, Raleigh, N. C	Received in good order; loss very small.
	11	1,000,000	R. O. Sweeny, Saint Paul, Minn	Arrived in good order; loss very light.
	12	1,000,000	do	Do.
	20	2,000,000	Seth Weeks, Corry, Pa	Do.
Feb.	12	1,000,000	Fred Mather, Cold Spring Harbor, N. Y.	Arrived in good condition, though so far advanced that a few hatched on the way.
	22	1,000,000	Charles G. Atkins, Bucksport, Me.	General condition on arrival good, but a small percentage hatched on the way.
Total		11,810,000		

The fry from Northville were distributed by car No. 2, of the United States Fish Commission, in charge of J. F. Ellis, and assistants N. Simmons, C. H. Ellis, and J. H. Horan. The Alpena fry were distributed by car and boat, the former connecting with the latter at Bay City and Saint Ignace, Mich. In all, the car was run over 7,000 miles. No charge for dispatching service was made by any of the railroad companies excepting the New York Central and Chicago and Northwestern. In making deposits care was taken to convey the minnows to a point not less than 2 miles from shore, tugs being employed for this purpose when procurable. Thirteen trips were made by the car, as follows:

Trip No. 1.—Left Northville February 24, at 4 p. m., with 2,000,000 minnows in eighty cans having a total capacity of 600 gallons; proceeded to Toledo by the Flint and Père Marquette Railroad; thence by the Lake Shore and Michigan Southern to Cleveland, where the fish were deposited in Lake Erie, at 7.30 p. m., February 25. The fish were taken from water at a temperature of 40°, held in the car twenty-seven hours in water varying from 35° to 43°, and deposited, in good condition, in water at 34°. The car returned to Northville by same route as outward trip, arriving February 27.

Trip No. 2.—Left Northville at 3 p. m., February 28, with 3,000,000 minnows in seventy-six cans; proceeded to Detroit by the Flint and Père Marquette Railroad; thence to Niagara Falls by the Great Western Division of the Grand Trunk; thence by the New York Central to Charlotte; thence, by the Rome, Watertown and Ogdensburg, to Oswego, where the fish were deposited, in good condition, at 1.30 p. m., March 2, in Lake Ontario. Temperature of water from which the fish were taken, 44°; average temperature of water in the can, 37°, varying from 35½° to 39°; temperature of lake at time of deposit, 34°. The car returned by same route as outward trip, arriving at Northville March 5. Arrangements had been made with the Rome, Watertown and Ogdensburg Railroad Company for free dispatching service between Suspension Bridge and Lake Ontario points, but the loss of a bridge near Charlotte made it necessary to take another route as far as Charlotte.

Trip No. 3.—Car left Northville at 3 p. m., March 7, with 3,000,000 minnows in seventy-six cans; proceeded to Charlotte, N. Y., by same

route as preceding trip, and deposited the fish in Lake Ontario, near Charlotte, in good condition at 5 p. m., March 8. Temperature of water from which the fry were taken, 45° ; temperature of water in car, from 35½° to 39° ; temperature of lake at time and place of deposit, 33°. On the return trip the car met with a slight accident at Charlotte, and another, with more serious results, near Suspension Bridge, on the Canada side. While switching to the main track at Charlotte, the engineer in charge of the yard engine very carelessly took a side track flanked with piles of ties, and, in turning a curve, the car received a severe raking along one side, sustaining considerable damage. Repairs were made by the company at their shops at Rochester. The accident near Suspension Bridge occurred while the car was side-tracked. Another car was backed against it with such violence that both platforms were broken and one end stove in. Mr. Ellis was in his state-room at that end of the car when the crash came, but escaped with slight injuries. The car was repaired by the Grand Trunk Company, at their car-shops, at London. The company also replaced broken crockery, etc. The car was detained nearly five days.

Trip No. 4.—This trip was an exact duplicate of trip No. 2, in regard to the number of cans used, the number of minnows carried, the route taken, and point of deposit. The car left Northville at 3 p. m., March 15, and arrived at Oswego about 3 p. m. the day following. The fish went through in good order, and were placed in Lake Ontario at 4 p. m. Temperature of water at the hatchery when the fish were removed, 43° ; temperature of water in the car, 37° to 41° ; temperature of lake at time of deposit, 35°.

Trip No. 5.—Car left Northville at 2 a. m., March 20, with 3,000,000 minnows in seventy-six cans ; proceeded to Toledo over the Flint and Père Marquette Railroad ; thence to Monroeville by the Lake Shore and Michigan Southern ; thence by the Baltimore and Ohio to Sandusky, arriving at 10 a m. on the same day. The car was transferred to the boat-landing an hour later. At 2 p. m. the fish were all placed in six cylinder and six ordinary cans and carried aboard the steamer Eagle, which left at 3 p. m. for the islands. Two hours later, when near Kelley's Island, the largest of the group, one-half the fish were deposited, the captain very kindly slacking the boat for this purpose. The remainder of the fish were planted off the west side of Put-in-Bay. Temperature of water at hatchery when fish were moved, 39° ; temperature of water in car, from 35° to 37° ; temperature of lake, 35°.

Trip No. 6.—The car left Northville at 2 a. m., March 29, with 2,000,000 minnows in sixty-four cans, and proceeded to Sandusky by same route taken in trip No. 5. As the regular daily boat to the islands was too crowded with freight to take the cans, the captain furnished a tug, which answered the purpose well. The fish were planted near Put-in-Bay Island at 7 p. m. Temperature of water at hatchery when the fish were moved, 45°; temperature of water in the car, 37° to 39° ; tempera-

ture of lake at time of deposit, 34°. This trip cleared the tanks of the Northville hatchery, with exception of a few hundred retained for experiments in feeding.

Trip No. 7.—The starting-point for the car in the first four trips with fish from Alpena was at Bay City, and for the remaining three trips. Point Saint Ignace, the extreme southeastern point of the Upper Peninsula.

The fish for this trip, 2,000,000 in number, were shipped from Alpena in charge of two messengers, per steamer Arundell, leaving at 3 p. m., April 24, and arriving at Bay City the following morning. They were then hauled to the car, nearly one-half mile, and placed in fifty of the automatic cans. The fish were in fine condition when the boat arrived, the water having been replaced with a fresh supply from the lake every two hours since leaving Alpena, but some were lost before delivery to the car, too few cans being employed in making the transfer from the boat. The car left Bay City at 11 a. m., going to Holly over the Flint and Père Marquette Railroad; thence by the Detroit, Grand Haven and Milwaukee road to Grand Haven, the fish being deposited about 5 miles southwest of this point, in Lake Michigan, at 10 a. m., April 26. Temperature of water at hatchery when fish were moved, 39½°; temperature of water used between Alpena and Grand Haven, 36° to 44°; temperature of lake at time and place of deposit, 38°. About 500 pounds of ice were used by the car on this trip.

Trip No. 8.—The fish for this trip, 2,000,000 in number, were delivered to the car and placed in sixty-four automatic cans on the morning of April 27, having been shipped from the hatchery about noon the day previous. The car left Bay City at 2.40 p. m., and was run direct to Ludington, the point of deposit, over the Flint and Père Marquette Railroad. The fish were deposited about 3 miles from Ludington, in Lake Michigan, at 10.30 a. m., April 28. Temperature of water at hatchery when fish were moved, 38½°; of the water on fish in transit, 38° to 45°; of the lake, where the fish were released, 38°. Five hundred pounds of ice were used on this trip.

Trip No. 9.—The car left Bay City at 7.15 a. m., May 1, with 2,000,000 minnows, shipped from Alpena the day before; proceeded to Reed City by the Flint and Père Marquette road; thence to Petoskey, the point of deposit, by the Grand Rapids and Indiana road. The fish were deposited in Lake Michigan at 8 a. m., May 2. Temperature of water at hatchery when fish were moved, 40°; of the water in transit, 38° to 45°; of the lake where the fish were set free, 35°. Ice used, 1,000 pounds.

Trip No. 10.—The car left Bay City at 8.45 p. m., May 4, with 4,000,000 minnows in 74 automatic cans; was dispatched to Flint over the Flint and Père Marquette road, thence to Chicago over the Chicago and Grand Trunk; thence by the Chicago and Northwestern to Kenosha and Milwaukee, the fish being planted one-half at the former and one-half at the latter place, in Lake Michigan, at 2 and 5 p. m., respectively,

May 5. Temperature of water at the hatchery when fish were moved, 40°; of the water in transit, 38° to 45°; of the lake where fish were planted, 42° at Kenosha and 39° at Milwaukee. Ice used, 1,200 pounds. The car proceeded from Milwaukee to Negaunee by the Chicago and Northwestern; thence by the Marquette, Houghton and Ontonagon to Marquette; thence by the Detroit, Mackinac and Marquette road to Point Saint Ignace.

Trip No. 11.—Left Saint Ignace at 9 a. m., May 10, with 2,000,000 minnows in 50 automatic cans, going over the Detroit, Mackinac and Marquette road to Marquette, where the fish were deposited in Lake Superior, 2 miles out, at 7.30 p. m., same day. Temperature of water at hatchery, 43½°; of the water in transit, 38° to 46°; of the lake at point of deposit, 34°. Large fields of ice were observed in the lake near Marquette.

Trip No. 12.—Left Saint Ignace at 8 p. m., May 14, with 2,000,000 minnows in 50 automatic cans, going to Marquette as before, and connecting there with the Marquette, Houghton and Ontonagon road for L'Anse, where the fish were deposited in Lake Superior, 3 miles out, at 7.30 p. m., May 15. Temperature of water at hatchery, 43½°; of the water in transit, 38° to 41°; of the lake where the fish were released, 35°.

Trip No. 13.—Left Saint Ignace by the usual route to Marquette, at 8 a. m., May 19, with 2,000,000 minnows in 50 cans; proceeded from Marquette by the Marquette, Houghton and Ontonagon road to Lake Michigamme, where 1,000,000 fish were deposited at 9.30 p. m., same day. The car then returned by the last-named road to Negaunee and proceeded thence by the Chicago and Northwestern road to Milwaukee, where the remaining million fish were planted in Lake Michigan, at 8 a. m., May 22. Temperature of water at hatchery, when fish were moved, 43½°; of the water in transit, 42° to 50°; of Lake Michigamme, 40°; of Lake Michigan, 43°. Number of pounds of ice used, 1,500. The Michigamme plant was made at the request of the Michigan Fish Commission. This trip closed the season at Alpena. The car then went on to Chicago by the Chicago and Northwestern; to Toledo by the Lake Shore and Michigan Southern, arriving May 23; thence to Washington by the usual route.

While the car-work in connection with the Alpena distribution was in progress seven lots of fish were run out by boat from Alpena, and deposited in the bay and down the shore of the lake (Huron) as follows:

April 23, near Sulphur Island	2,000,000
April 28, near Alcona	3,000,000
April 29, near North Point	2,000,000
May 2, near Black River	2,000,000
May 6, near Ossineke	3,000,000
May 7, near Oscoda	2,000,000
May 16, near Partridge Point	2,000,000

On May 12, 100,000 fish were deposited in Long Lake, an inland sheet of considerable dimensions, near Alpena; 15,000 were also deposited in Lake Huron, near Oscoda, to the credit of the Michigan commission, to offset a like number delivered from the Detroit hatchery to Hiram Lindsey, April 25, for deposit in Lindsey Lake, Indiana, to the credit of the United States Commission; making, in all, 32,115,000 whitefish as the result of the season's work at Alpena.

For experiment a few hundred of the fry were left in one of the tanks when the hatchery was closed, May 16. From one of the inlet pipes the tank containing the fry was supplied with a small driblet of water, sufficient, perhaps, to amount to 200 gallons per day. It was expected that all would die soon after the absorption of the sac, as the young of this species almost invariably do when confined in this way, even when supplied with the water of their natural habitat, as they were in this instance; but on visiting the hatchery, August 18, I found some fifty to sixty specimens, active and vigorous, varying from 1 to 3 inches in length. These fish had derived their food supply wholly from the water, no artificial aid or food having been given them.

The experiment of growing young whitefish in confinement, with the aid of artificial feeding, is now being successfully conducted at the Northville hatchery. We started in with 1,200 to 1,500 of the fry, hatched March 15, and to-day (September 1) have 276 fish, the least of which is not less than 3, and the greatest not less than 6, inches in length. So far as I am aware this eclipses any attempt of the kind hitherto recorded. They were treated much the same as the young trout, being fed wholly on liver reduced to various degrees of fineness, according to the size of the fish. Although very small and frail at first, they grow very rapidly when once started.

RECAPITULATION.

Whitefish were distributed to the great lakes as follows:

To Lake Ontario	9,000,000
To Lake Erie	7,000,000
To Lake Huron	16,000,000
To Lake Superior	4,000,000
To Lake Michigan	11,000,000
	47,000,000

The following table combines the results of both stations for the season:

	Eggs received.	Eggs shipped.	Fish hatched.	Fish shipped.
German trout	1,400		1,330	
Rainbow trout	45,150		6,400	
Brook trout	473,000	357,000	50,000	15,000
Land-locked salmon	20,000		19,800	18,800
Lake trout	277,000	203,000		
Whitefish	71,800,000	11,810,000	48,118,000	48,115,000

Record of temperature and weather observations made at the United States Fish Hatchery, Northville, Mich., from November 1, 1882, to July 1, 1883.

Date.	Temperature of—						Wind.						Condition of—		
	Air, 8 a. m.	Water, 8 a. m.	Air, 12 m.	Water, 12 m.	Air, 5 p. m.	Warer, 5 p. m.	Direction, 8 a. m.	Intensity, 8 a. m.	Direction, 12 m.	Intensity, 12 m.	Direction, 5 p. m.	Intensity, 5 p. m.	Sky, 8 a. m.	Sky, 12 m.	Sky, 5 p. m.
1882.	°F.	°F.	°F.	°F.	°F.	°F.									
Nov. 1	36	50	42	51	50	51	N. E.	Brisk	N. W.	Mild	N. E.	Light	Clear	Clear	Clear
Nov. 2	32	47	43	48	40	49	N. E.	...do	N. E.	...do	N. E.	...do	...do	Cloudy	...do
Nov. 3	31	45	43	46	38	48	N. E.	Mild	S. E.	...do	S. E.	Calm	Cloudy	Clear	Hazy
Nov. 4	36	45	43	46	38	48	S. E.	Light	E.	Light	S. E.	...do	Clear	Cloudy	...do
Nov. 5	40	44	50	46	45	47	S. E.	...do	S. E.	...do	S. E.	...do	Hazy	...do	Cloudy
Nov. 6	42	46	47	47	47	48	S. E.	...do	S. E.	...do	S. E.	Mild	Cloudy	...do	...do
Nov. 7	38	48	50	50	50	45	S. E.	Calm	W.	Brisk	W.	...do	...do	...do	...do
Nov. 8	32	46	54	49	50	50	S. W.	...do	S. W.	Calm	W.	Calm	Foggy	Foggy	...do
Nov. 9	47	48	52	48	52	50	N. W.	...do	S E.	...do	S. E.	...do	...do	...do	Foggy
Nov. 10	48	50	53	50	52	50	S. E.	Mild	S. W.	Mild	S. W.	Mild	...do	Cloudy	...do
Nov. 11	58	51	66	53	63	53	S.	Light	S. W.	Brisk	S. W.	...do	Cloudy	...do	Cloudy
Nov. 12	57	52	52	54	50	53	S. W.	Brisk	S. W.	...do	S W.	...do	...do	Clear	...do
Nov. 13	32	46	30	45	28	45	S. W.	Light	N. W.	...do	N. W.	Brisk	...do	Cloudy	...do
Nov. 14	26	42	37	46	33	46	N. W.	...do	N. W.	Light	N. W.	Light	Clear	Clear	...do
Nov. 15	27	42	42	46	40	46	N. W.	...do	W.	Brisk	W.	Calm	...do	Cloudy	...do
Nov. 16	36	47	46	46	42	47	W.	Calm	W.	Calm	S. W.	...do	Cloudy	Clear	...do
Nov. 17	32	45	40	46	32	46	W.	Brisk	E.	Light	E.	Light	...do	Cloudy	Clear
Nov. 18	26	42	38	46	31	46	E.	Calm	N.	Calm	N. W.	Calm	Clear	...do	...do
Nov. 19	36	44	40	46	34	46	N. E.	Light	N. E.	Light	E.	...do	Cloudy	...do	Cloudy
Nov. 20	19	42	39	45	32	45	N. W.	Calm	S. E.	...do	E.	...do	Clear	Clear	...do
Nov. 21	30	43	40	45	38	45	W.	Light	S. W.	...do	S. W.	Light	Cloudy	Cloudy	...do
Nov. 22	32	44	40	46	38	46	W.	...do	S. W.	Brisk	S. W.	Calm	...do	...do	...do
Nov. 23	34	44	35	44	35	44	S. E.	...do	S. W.	Light	W.	Strong	...do	...do	...do
Nov. 24	30	40	33	41	32	42	N. W.	Strong	N. W.	Strong	N. W.	Light	...do	...do	...do
Nov. 25	26	40	36	42	33	43	W.	Mild	S. W.	Light	S. W.	Calm	Clear	Clear	...do
Nov. 26	28	40	36	42	32	42	S. E.	Light	W.	...do	W.	...do	Cloudy	Cloudy	...do
Nov. 27	28	40	34	42	30	43	N. W.	Calm	W.	...do	W.	...do	...do	Clear	...do
Nov. 28	28	41	28	40	26	40	N. E.	Light	E.	Brisk	E.	Light	...do	Cloudy	...do
Nov. 29	26	38	32	40	26	40	N. E.	...do	N. E.	Light	N. E.	...do	...do	...do	...do
Nov. 30	19	38	28	40	26	40	S. W.	...do	N. W.	Brisk	N. W.	Strong	...do	...do	...do
Dec. 1	28	39	30	40	32	41	S. W.	...do	W.	Mild	S. W.	Mild	...do	...do	...do
Dec. 2	30	42	24	40	23	40	N. W.	Brisk	N. W.	...do	N. E.	...do	...do	...do	...do
Dec. 3	20	38	27	40	22	40	N. W.	Mild	S. W.	Light	S. W.	Calm	...do	...do	...do
Dec. 4	26	38	37	40	37	40	S. W.	...do	W.	Mild	W.	Fresh	...do	...do	...do

Record of temperature and weather observations made at the United States Fish Hatchery, Northville, Mich., &c.—Continued.

Date.	Temperature of— Air, 8 a. m.	Water, 8 a. m.	Air, 12 m.	Water, 12 m.	Air, 5 p. m.	Water, 5 p. m.	Wind. Direction, 8 a. m.	Intensity, 8 a. m.	Direction, 12 m.	Intensity, 12 m.	Direction, 5 p. m.	Intensity, 5 p. m.	Condition of— Sky, 8 a. m.	Sky, 12 m.	Sky, 5 p. m.
1882.	°F.	°F.	°F.	°F.	°F.	°F.									
Dec. 5	17	38	34	40	30	40	N. W.	....do	S. W.	....do	W.	Light	Cloudy	Cloudy	Cloudy
Dec. 6	22	38	26	40	22	33	N. W.	Brisk	S. W.	Light	N. W.	....do	....do	....do	....do
Dec. 7	4	32	8	33	5	37	N. W.	Strong	N. W.	Strong	W.	Brisk	Clear	Clear	....do
Dec. 8	0	34	10	36	6	38	N. W.	Brisk	N. W.	Brisk	W.	....do	Cloudy	Cloudy	....do
Dec. 9	12	36	23	38	20	38	S. W.	Light	S. W.	Light	W.	Light	....do	....do	....do
Dec. 10	30	37	32	38	24	39	S. W.	....do	S. W.	....do	S. W.	....do	....do	....do	....do
Dec. 11	21	38	26	36	21	39	N. W.	Brisk	S. W.	....do	W.	....do	....do	....do	....do
Dec. 12	20	38	38	38	34	40	S.	Calm	S. E.	....do	S. E.	....do	....do	....do	....do
Dec. 13	32	40	23	40	18	38	W.	Light	W.	Brisk	N. W.	Strong	....do	....do	....do
Dec. 14	20	38	24	40	21	40	N. W.	....do	N. W.	Light	N. W.	Light	....do	....do	....do
Dec. 15	11	35	20	35	17	34	N. W.	....do	N. W.	Calm	N. W.	....do	Clear	....do	....do
Dec. 16	17	35	24	32	22	36	N. W.	Brisk	N. W.	Brisk	N. W.	....do	Cloudy	....do	....do
Dec. 17	—4	36	18	37	20	36	S. W.	Light	S. W.	Light	S. W.	....do	....do	Clear	....do
Dec. 18	15	37	28	38	28	38	W.	....do	E.	....do	S. E.	....do	Clear	Cloudy	....do
Dec. 19	28	37	29	37	30	38	S. E.	....do	E.	....do	E.	....do	....do	Clear	....do
Dec. 20	38	38	32	39	33	39	S. E.	....do	S. E.	....do	S. E.	....do	Cloudy	Cloudy	....do
Dec. 21	34	40	42	42	42	42	S. E.	....do	S. E.	....do	S. E.	Calm	....do	....do	....do
Dec. 22	30	43	35	44	35	44	S. W.	Calm	S. E.	Calm	S.	....do	....do	....do	....do
Dec. 23	31	42	32	42	34	43	S. W.	....do	W.	Light	W.	....do	....do	....do	....do
Dec. 24	28	40	35	41	34	41	W.	Light	W.	....do	W.	Light	....do	....do	....do
Dec. 25	32	42	45	42	43	43	S. W.	....do	S.	....do	S.	....do	....do	....do	....do
Dec. 26	32	42	44	41	43	42	E.	....do	E.	....do	E.	....do	....do	....do	....do
Dec. 27	30	41	33	44	34	44	E.	Mild	S. E.	....do	S. E.	Calm	....do	....do	....do
Dec. 28	28	44	35	44	33	44	N. E.	Calm	S. E.	Calm	E.	....do	....do	....do	....do
Dec. 29	27	42	34	43	30	42	W.	Light	W.	....do	W.	Light	....do	Clear	....do
Dec. 30	24	41	32	41	28	42	S. W.	....do	S. W.	Light	S. W.	Brisk	....do	Cloudy	....do
Dec. 31	22	40	28	40	26	41	W.	....do	N. W.	....do	N. W.	Light	....do	....do	....do
1883.															
Jan. 1	18	38	24	38	19	38	W.	....do	W.	....do	W.	Calm	Cloudy	Cloudy	Cloudy
Jan. 2	18	37	22	38	28	38	N. W.	Brisk	N. W.	....do	N. W.	....do	....do	....do	Clear
Jan. 3	18	37	27	37	18	37	S. W.	....do	W.	Brisk	W.	Light	....do	Clear	....do
Jan. 4	6	36	18	37	19	37	N. W.	Light	N. E.	Light	N. E.	....do	....do	Cloudy	Cloudy
Jan. 5	17	36	18	36	18	37	E.	....do	N. E.	....do	N. E.	Calm	....do	....do	....do
Jan. 6	18	38	18	38	25	38	S.	Calm	S. W.	Calm	S. W.	....do	....do	....do	....do
Jan. 7	24	38	30	39	21	40	W.	Brisk	N. W.	Light	W.	....do	....do	Clear	Clear

Jan.	8	14	38	17	38	14	38	N. E.	Light	N. E.	do	E.	do	do	do	Cloudy
Jan.	9	—10	38	22	37	20	38	S. W.	Calm	W.	Calm	N. W.	do	Clear	do	Clear
Jan.	10	12	38	22	38	20	38	E.	Light	S. E.	Light	S. E.	Light	Cloudy	Cloudy	Cloudy
Jan.	11	6	37	14	37	19	37	N. E.	do	E.	do	E.	Calm	do	do	do
Jan.	12	3	37	22	37	20	37	S. W.	Calm	S. E.	do	S. E.	Brisk	do	do	do
Jan.	13	34	38	27	38	17	37	S. W.	Strong	S. W.	Strong	W.	Light	do	Clear	do
Jan.	14	10	36	18	34	14	38	W.	Light	W.	Brisk	W.	do	do	do	Clear
Jan.	15	3	36	18	36	14	40	W.	Calm	W.	Calm	W.	Calm	do	Cloudy	Cloudy
Jan.	16	12	38	28	38	24	39	S. E.	do	S. E.	Light	E.	do	do	do	do
Jan.	17	25	39	32	38	33	38	S. E.	Light	S. W.	do	E.	Brisk	do	do	do
Jan.	18	10	38	28	38	26	39	W.	do	N. W.	Calm	E.	Light	do	Clear	Clear
Jan.	19	21	37	32	38	25	38	S. E.	do	S. W.	Light	E.	do	do	Cloudy	Cloudy
Jan.	20	19	37	30	38	24	38	E.	do	S. E.	do	E.	do	do	do	do
Jan.	21	—8	34	—4	32	—2	32	W.	Brisk	W.	Brisk	S. W.	Brisk	do	Clear	Clear
Jan.	22	—16	33	—9	35	—10	36	W.	do	N. W.	Strong	W.	do	Clear	do	do
Jan.	23	—12	37	—2	37	—2	38	W.	Light	W.	Brisk	W.	Light	Cloudy	Cloudy	Cloudy
Jan.	24	3	37	20	38	18	38	S. W.	do	S. W.	Light	S. W.	do	do	do	do
Jan.	25	8	37	12	37	10	37	W.	Light	W.	Light	W.	do	do	Clear	Clear
Jan.	26	2	38	26	38	20	38	E.	Calm	E.	do	W.	do	Clear	do	Cloudy
Jan.	27	34	38	33	38	30	39	W.	Light	W.	do	S. W.	Calm	Cloudy	Cloudy	do
Jan.	28	24	40	32	40	22	41	N. E.	Calm	W.	Calm	S. W.	do	do	do	Clear
Jan.	29	23	38	37	40	28	40	S. W.	Light	S. W.	do	S. W.	do	do	do	Cloudy
Jan.	30	33	40	39	40	38	42	S. E.	do	S. E.	do	W.	do	do	do	do
Jan.	31	16	37	18	37	14	37	S. W.	Brisk	S. W.	Brisk	S. W.	Brisk	do	do	do
Feb.	1	3	34	10	34	8	36	W.	do	W.	do	S. W.	Light	do	do	do
Feb.	2	7	37	17	37	12	38	S. E.	Light	S. E.	Light	S. E.	do	do	do	do
Feb.	3	20	36	26	37	28	38	N. E.	do	S. E.	do	S. E.	do	do	do	do
Feb.	4	14	38	20	38	16	38	W.	do	W.	Brisk	W.	do	Clear	do	do
Feb.	5	3	38	12	37	8	38	S. W.	do	S. W.	Light	S. W.	Calm	do	do	Clear
Feb.	6	—7	37	12	37	12	37	S. W.	Calm	S. W.	Calm	S. W.	do	do	do	Cloudy
Feb.	7	9	38	30	37	10	37	W.	do	W.	Light	S. W.	Light	do	Clear	do
Feb.	8	2	37	20	37	20	37	S. W.	Brisk	S. W.	Brisk	W.	Brisk	do	do	Clear
Feb.	9	10	37	28	37	15	39	S. W.	Light	S. W.	do	W.	Light	do	do	do
Feb.	10	—10	37	22	37	14	37	S. E.	Calm	N. E.	Light	E.	Calm	do	Cloudy	Cloudy
Feb.	11	20	38	26	39	26	40	S. E.	do	S. W.	do	S. W.	Light	Cloudy	do	do
Feb.	12	—2	38	31	39	17	39	W.	do	S. W.	do	S. W.	Calm	Clear	Clear	do
Feb.	13	2	38	44	39	18	39	S. E.	do	S. W.	do	E.	Light	Cloudy	Cloudy	do
Feb.	14	30	40	32	39	32	40	S. E.	Light	S. E.	do	S. E.	do	do	do	do
Feb.	15	33	42	38	42	35	44	S. W.	do	S. W.	Calm	S. W.	Calm	do	do	do
Feb.	16	39	44	43	44	48	44	S. W.	do	S. W.	do	N. W.	do	do	do	do
Feb.	17	21	38	23	38	18	38	N. W.	Brisk	N. W.	Brisk	N. W.	Light	do	do	do
Feb.	18	14	36	24	40	20	40	S. W.	Light	S. W.	Light	S. W.	do	Clear	Clear	Clear
Feb.	19	21	38	31	40	29	40	S. W.	do	S. W.	do	S. W.	Calm	Cloudy	Cloudy	Cloudy
Feb.	20	27	40	38	44	28	43	S. W.	do	S. W.	do	N. W.	Brisk	do	do	do
Feb.	21	17	39	27	42	28	42	N. W.	do	N. W.	do	N. W.	do	Clear	Clear	Clear
Feb.	22	22	40	30	41	28	44	N. W.	Brisk	N. W.	do	N. E.	Calm	Cloudy	Cloudy	Cloudy
Feb.	23	9	39	24	41	20	42	N. E.	Light	N. E.	do	N. E.	Light	Clear	Clear	do
Feb.	24	16	38	32	40	21	40	N. E.	do	N. E.	do	S. E.	do	Cloudy	Cloudy	do
Feb.	25	28	40	30	40	22	40	W.	do	N. E.	do	W.	Brisk	do	do	do
Feb.	26	21	38	19	40	18	38	W.	Strong	N. W.	Brisk	N. W.	Light	do	do	do
Feb.	27	3	36	20	39	24	39	W.	Brisk	S. W.	Strong	S. W.	Brisk	do	do	do
Feb.	28	30	40	40	44	34	48	N. E.	Light	S. E.	Calm	S. W.	Calm	do	do	do

Record of temperature and weather observations made at the United States fish hatchery, Northville, Mich., &c.—Continued.

Date.	Temperature of— Air, 8 a. m.	Water, 8 a. m.	Air, 1 p. m.	Water, 1. p. m.	Air, 5 p. m.	Water, 5 p. m.	Wind. Direction, 8 a. m.	Intensity, 8 a. m.	Direction, 1 p. m.	Intensity, 1 p. m.	Direction, 5 p. m.	Intensity, 5 p. m.	Condition of— Sky, 8 a. m.	Sky, 1 p. m.	Sky, 5 p. m.
1883.	°F.	°F.	°F.	°F.	°F.	°F.									
Mar. 1	32	37	44	48	39	51	S. W.	Light	S. W.	Light	S. W.	Light	Clear	Clear	Clear
Mar. 2	33	44	39	48	34	49	N. W.	Calm	N. E.	do	N. W.	Calm	do	do	Cloudy
Mar. 3	12	40	26	42	27	44	N. W.	Light	W.	Brisk	W.	Brisk	Cloudy	Cloudy	do
Mar. 4	20	42	30	44	26	44	N.	Brisk	N.	Light	N. E.	Light	Hazy	Hazy	Clear
Mar. 5	5	40	34	44	21	44	N. E.	Light	S. E.	do	S. E.	do	Cloudy	Cloudy	Cloudy
Mar. 6	24	40	34	42	30	42	S. E.	do	S. E.	Brisk	S. W.	Brisk	do	do	do
Mar. 7	8	38	24	41	20	44	N. W.	do	N. W.	Light	N. W.	Light	Clear	Clear	Clear
Mar. 8	— 4	38	26	44	20	45	S. W.	do	S. W.	do	S. W.	do	do	Cloudy	do
Mar. 9	14	40	48	46	42	48	E.	do	S.	do	S. W.	do	Hazy	Hazy	do
Mar. 10	34	44	33	47	29	47	W.	Calm	W.	Brisk	W.	do	Cloudy	Cloudy	Cloudy
Mar. 11	16	40	24	42	24	42	W.	Light	N. W.	Light	W.	Brisk	Clear	Clear	do
Mar. 12	24	40	29	48	26	42	W.	Brisk	W.	Strong	W.	Light	Cloudy	Cloudy	do
Mar. 13	16	42	44	48	40	48	W.	Calm	S. W.	Light	W.	do	Clear	Clear	Clear
Mar. 14	32	44	52	43	46	46	W.	Light	S. W.	Brisk	W.	do	do	do	do
Mar. 15	24	42	24	43	20	46	N. W.	do	N. W.	do	W.	do	Cloudy	Cloudy	Cloudy
Mar. 16	14	40	30	48	30	44	W.	do	W.	do	W.	do	Clear	do	do
Mar. 17	30	44	46	46	42	48	S. W.	do	S. W.	do	S. W.	do	Cloudy	Clear	do
Mar. 18	44	45	24	38	16	44	S. W.	do	N. E.	Light	N. E.	do	Hazy	Cloudy	do
Mar. 19	8	38	16	42	12	40	N. E.	Brisk	N. E.	Brisk	N. E.	do	Cloudy	do	do
Mar. 20	—12	38	20	46	17	44	N. W.	Light	S. W.	Light	S. W.	Calm	Clear	Clear	do
Mar. 21	— 3	40	29	46	24	47	S. W.	do	S. W.	do	N. W.	Light	do	Cloudy	do
Mar. 22	— 2	40	34	42	28	46	S. W.	do	S. W.	do	S. W.	Brisk	Cloudy	Clear	do
Mar. 23	24	40	26	45	24	43	N. W.	Brisk	N. W.	Strong	N. E.	Light	do	Cloudy	Clear
Mar. 24	— 4	40	34	46	32	48	S. W.	Calm	S. E.	Light	S. E.	Calm	Clear	Clear	do
Mar. 25	24	44	40	46	36	48	E.	Light	E.	do	E.	Light	Cloudy	Cloudy	Cloudy
Mar. 26	34	44	41	48	33	50	E.	do	S. E.	do	N. E.	do	do	do	do
Mar. 27	26	44	32	48	30	48	N. W.	do	N. W.	Strong	N. W.	Calm	do	do	do
Mar. 28	24	42	34	49	29	46	S. E.	do	S. W.	Light	S. W.	Light	do	do	do
Mar. 29	24	44	39	47	32	50	N. W.	do	S.	do	S. E.	do	do	do	Clear
Mar. 30	26	46	34	48	31	49	N. E.	Brisk	N. E.	do	N. E.	Calm	do	Clear	do
Mar. 31	24	44	34	46	32	48	N. E.	do	N. E.	Brisk	N. E.	Light	do	Cloudy	Cloudy
Apr. 1	20	44	30	45	30	47	N. E.	do	N. E.	do	N. E.	do	do	do	do
Apr. 2	22	42	34	48	37	49	N. E.	Light	N. E.	Light	E.	Calm	do	do	Clear
Apr. 3	32	48	49	48	34	47	W.	Brisk	W.	Brisk	W.	do	do	do	Cloudy
Apr. 4	40	48	48	47	28	48	N. E.	Light	N. W.	Light	S. W.	Light	do	Clear	Hazy
Apr. 5	41	47	49	48	30	48	N. W.	Brisk	W.	Light	W.	Light	Clear	Cloudy	Clear

Apr.	6	42	48	48	49	34	49	W.	Light	N. W.	do	E.	do	Cloudy	Clear	Cloudy
Apr.	7	30	44	50	48	35	49	N. E.	do	W.	do	N. E.	do	do	do	do
Apr.	8	32	48	50	49	36	56	W.	Brisk	W.	do	W.	Brisk	Clear	do	Clear
Apr.	9	30	50	54	56	40	56	W.	Light	W.	do	W.	do	do	do	do
Apr.	10	48	49	68	53	60	46	S. W.	Calm	S. W.	do	S. W.	Calm	do	do	Cloudy
Apr	11	40	50	56	57	52	52	W.	Light	S. W.	do	S. W.	Light	Cloudy	Cloudy	do
Apr.	12	40	48	54	50	58	53	E.	do	S. E.	do	S. E.	do	do	Hazy	do
Apr.	13	46	48	48	48	46	47	E.	do	S. W.	do	N. E.	do	do	Cloudy	do
Apr.	14	50	48	47	49	47	48	N. E.	do	W.	do	E.	do	Clear	Clear	Clear
Apr.	15	50	48	60	52	58	58	N. E.	Strong	N. W.	Brisk	S. W.	Strong	Cloudy	Cloudy	Cloudy
Apr.	16	65	54	57	52	55	54	S. W.	Brisk	N. E.	Strong	N. W.	do	do	do	Clear
Apr.	17	44	48	66	54	61	55	S. W.	Calm	N. E.	do	S. E.	Calm	Clear	Clear	Cloudy
Apr.	18	46	48	68	52	60	56	N. W.	do	N. E.	Light	S. E.	Brisk	Cloudy	Cloudy	do
Apr.	19	48	50	50	50	48	54	N. E.	do	S. E.	do	S. E.	Calm	do	do	do
Apr.	20	45	50	52	50	54	58	E.	Brisk	E.	do	E.	do	Clear	do	do
Apr.	21	38	46	62	56	54	54	N. E.	Calm	N. E.	do	S. E.	Light	Cloudy	Clear	do
Apr.	22	46	50	44	48	42	56	S. E.	Brisk	N. W.	Brisk	N. E.	Brisk	do	Cloudy	do
Apr.	23	42	48	46	47	36	48	N. E.	Strong	N. W.	Strong	N. E.	do	do	do	do
Apr.	24	34	44	39	47	38	48	N. E.	Light	S. W.	do	N. W.	do	do	do	do
Apr.	25	29	43	52	50	54	46	N.	do	W.	Light	W.	Light	Clear	Clear	do
Apr.	26	31	42	50	59	52	52	N.	do	N. E.	do	W.	do	Cloudy	Cloudy	do
Apr.	27	42	48	66	50	48	50	S. E.	Calm	N. E.	Brisk	N. W.	Calm	do	do	do
Apr.	28	44	46	46	48	46	48	N. W.	Light	N. W.	do	E.	Light	do	do	do
Apr.	29	35	44	42	51	48	54	E.	Calm	N. E.	Light	N. W.	Calm	Clear	do	Clear
Apr.	30	40	43	63	52	57	52	W.	Light	N. W.	do	W.	do	Cloudy	do	Cloudy
May	1	39	48	67	54	60	56	E.	do	S.	do	S. E.	Calm	do	do	Clear
May	2	49	50	72	52	64	52	N. E.	Calm	W.	do	E.	Light	do	do	Cloudy
May	3	47	50	66	52	48	54	S. E.	Light	S. E.	do	N. W.	do	do	do	do
May	4	46	50	58	50	54	52	S. W.	do	S. E.	do	S. E.	do	do	do	do
May	5	46	48	56	50	53	52	N. W.	Brisk	N. W.	do	W.	do	do	do	do
May	6	46	48	60	56	54	58	N. W.	Calm	W.	do	W.	do	Clear	Clear	Clear
May	7	45	52	76	58	70	59	W.	Light	S. W.	Brisk	S. W.	do	Cloudy	Cloudy	do
May	8	54	50	59	53	58	54	N. W.	do	S. W.	Calm	E.	do	do	do	Cloudy
May	9	50	50	65	52	58	54	N. E.	do	S. E.	Brisk	S. E.	do	do	do	do
May	10	42	52	59	54	56	54	S. W.	do	S. W.	Light	S. W.	Calm	do	do	do
May	11	57	48	49	54	53	50	N. W.	do	W.	Brisk	S. W.	Brisk	Clear	do	Clear
May	12	30	49	48	52	49	49	S. W.	Calm	S. W.	do	E.	Light	do	do	Cloudy
May	13	32	48	39	57	47	52	N. E.	Brisk	N. W.	Light	N. E.	do	do	do	do
May	14	34	49	39	49	38	49	S. E.	Strong	S. E.	do	N. E.	do	Cloudy	do	do
May	15	32	48	50	54	36	48	N. E.	do	N. W.	Brisk	N. E.	do	do	do	do
May	16	34	48	48	56	59	49	N. E.	Calm	N. W.	Light	S. E.	do	Clear	Clear	do
May	17	33	49	62	56	46	58	W.	do	S. W.	Calm	S. E.	Calm	do	Hazy	do
May	18	42	52	54	54	58	59	S. E.	Light	S. W.	Brisk	S. W.	Brisk	Cloudy	Cloudy	do
May	19	60	52	70	60	66	62	S. E.	Brisk	S. W.	do	S. W.	do	do	do	do
May	20	52	54	54	56	48	56	S. W.	Light	W.	Light	N. W.	Calm	do	do	do
May	21	30	47	36	46	35	44	N. E.	Strong	N. E.	Brisk	N. E.	Strong	do	do	do
May	22	34	42	38	44	38	45	N. E.	do	N. E.	Light	N. E.	Light	do	do	do
May	23	38	44	60	50	65	56	N. W.	Light	N. E.	Strong	S. W.	Calm	do	Clear	Clear
May	24	42	49	70	58	58	58	N. W.	do	W.	Light	S. W.	Light	Clear	do	Cloudy
May	25	57	54	79	62	68	64	S. W.	do	S. W.	do	S. W.	do	Cloudy	do	do
May	26	58	56	57	54	58	54	S. W.	do	N. E.	do	S. W.	Calm	do	Cloudy	do
May	27	50	49	52	55	50	53	S. W.	do	S. W.	Brisk	N. E.	Light	do	do	do

Record of temperature and weather observations made at the United States Fish Hatchery, Northville, Mich., &c.—Coutinued.

Date.	Temperature of— Air, 8 a. m.	Water, 8 a. m.	Air, 1 p. m.	Water, 1 p. m.	Air, 5 p. m.	Water, 5 p. m.	Wind. Direction, 8 a. m.	Intensity, 8 a. m.	Direction, 1 p. m.	Intensity, 1 p. m.	Direction, 5 p. m.	Intensity, 5 p. m.	Condition of— Sky, 8 a. m.	Sky, 1 p. m.	Sky, 5 p. m.
1883.	°F.	°F.	°F.	°F.	°F.	°F.									
May 28	50	51	60	54	52	56	W.	Light	S. W.	Light	W.	Light	Clear	Cloudy	Cloudy
May 29	49	51	66	59	57	58	N. E.	do	W.	do	S. W.	Calm	do	do	do
May 30	51	50	54	56	48	52	S. E.	do	S. E.	do	S. W.	Light	Cloudy	do	Clear
May 31	49	57	59	54	58	58	N. W.	Brisk	W.	Brisk	N. W.	do	do		
June 1	50	54	71	56	60	58	S. E.	Calm	S.	Light	S. E.	Calm	Clear	Clear	Clear
June 2	51	51	80	58	59	64	S. E.	do	S. W.	do	S. E.	do	do	do	do
June 3	71	56	71	59	64	68	S. E.	Brisk	S.	Strong	S. W.	do	Cloudy	Cloudy	Cloudy
June 4	62	58	65	58	74	69	S. W.	Light	S. W.	Light	S. W.	do	do	do	Clear
June 5	56	53	82	68	66	59	E.	do	S. W.	do	S. W.	do	do	do	Cloudy
June 6	68	54	72	60	68	59	S. W.	do	S. W.	Brisk	S. W.	do	do	do	do
June 7	60	58	74	68	66	67	S. W.	Calm	W.	Strong	W.	Light	Hazy	do	Clear
June 8	64	54	81	69	64	66	S. E.	do	S. E.	Calm	E.	do	Clear	do	Cloudy
June 9	59	54	76	64	68	60	N. E.	Light	S. W.	Brisk	S. W.	do	Cloudy	do	do
June 10	64	54	62	52	56	54	S. E.	do	S. E.	Light	S. W.	do	do	do	do
June 11	62	53	68	58	70	60	N. W.	Brisk	N. W.	Brisk	S. W.	do	do	do	Clear
June 12	56	63	70	59	68	62	S. W.	Light	N. W.	Light	N. W.	do	do	do	Cloudy
June 13	58	54	64	58	65	58	S. W.	Brisk	S. W.	do	N. W.	Calm	do	do	do
June 14	54	50	64	58	70	60	W.	Calm	S. W.	do	S. E.	do	Clear	Clear	Clear
June 15	62	56	65	57	69	60	E.	do	S. W.	do	S. W.	do	do	Cloudy	Cloudy
June 16	64	56	72	60	72	61	S. W.	Light	S. W.	do	S. W.	Light	Cloudy	do	do
June 17	74	68	76	62	69	60	S. W.	Brisk	S. W.	Calm	S.	Calm	Clear	do	do
June 18	70	64	79	64	76	62	S. W.	Calm	S. W.	Light	S. W.	Brisk	Cloudy	do	do
June 19	66	56	74	62	58	60	W.	Brisk	S. W.	do	N. W.	Light	do	do	do
June 20	58	56	69	58	70	60	N. W.	do	N. W.	Brisk	W.	do	do	do	Clear
June 21	66	56	78	68	66	60	S. W.	Light	S. W.	Calm	W.	Calm	do	do	Cloudy
June 22	65	52	70	62	79	62	S. W.	do	S. W.	do	S.	do	Clear	Clear	Clear
June 23	64	51	68	54	70	62	S. W.	do	S. W.	do	S.	Light	do	Cloudy	Cloudy
June 24	66	56	72	55	70	60	S. W.	do	S. W.	Light	S. W.	Calm	do	do	do
June 25	65	54	64	53	62	57	N. E.	do	N. E.	do	N. E.	Light	Foggy	do	do
June 26	68	63	65	54	62	57	N. W.	do	S. W.	do	S. W.	do	Cloudy	do	do
June 27	58	52	70	69	63	58	W.	Calm	W.	do	S. E.	Calm	do	do	do
June 28	62	54	66	60	62	58	N. W.	Light	W.	do	S. W.	do	do	do	do
June 29	58	68	63	60	58	56	S. W.	do	N. W.	do	N. W.	do	do	do	do
June 30	64	54	62	60	68	59	S. E.	Brisk	N. E.	do	S. E.	do	do	do	Clear

Record of water-temperature observations made at the United States hatchery, Alpena, Mich., from November 10, 1882, *to May* 16, 1883.

Date.	8 a. m.	8 p. m.	Date.	8 a. m.	8 p.m.	Date.	8 a. m.	8 p.m.	Date.	8 a. m.	8 p. m.
1882.	°F.	°F.		°F.	°F.		°F.	°F.		°F.	°F.
Nov. 10	52	54	Dec. 28	35½	35	Feb. 13	34½	35	Apr. 2	34	34
Nov. 11	50	51	Dec. 29	35	35	Feb. 14	34½	35	Apr. 3	34	34
Nov. 12	51	52	Dec. 30	34½	34½	Feb. 15	34½	34½	Apr. 4	34	34
Nov. 13	48	49	Dec. 31	35	35½	Feb. 16	34	34	Apr. 5	34	34
Nov. 14	46	47	1883.			Feb. 17	34	34½	Apr. 6	34½	34
Nov. 15	47	50	Jan. 1	34	34½	Feb. 18	34	34½	Apr. 7	34½	34½
Nov. 16	48	50	Jan. 2	34	34½	Feb. 19	34½	34½	Apr. 8	34½	34½
Nov. 17	41	43	Jan. 3	34	34½	Feb. 20	34½	34½	Apr. 9	34½	35
Nov. 18	43	45	Jan. 4	34	34	Feb. 21	34	34	Apr. 10	35	35½
Nov. 19	41	42	Jan. 5	34	35	Feb. 22	34	34½	Apr. 11	35½	36
Nov. 20	40	41	Jan. 6	34	34½	Feb. 23	34	34½	Apr. 12	36	36
Nov. 21	41	43	Jan. 7	34½	35	Feb. 24	34	34	Apr. 13	36	36
Nov. 22	42	43	Jan. 8	35	35	Feb. 25	34	34	Apr. 14	36	36
Nov. 23	39	40	Jan. 9	35	34½	Feb. 26	34	34	Apr. 15	36	36
Nov. 24	40	41	Jan. 10	35	35	Feb. 27	34	34	Apr. 16	36	36
Nov. 25	38	39	Jan. 11	35	35	Feb. 28	34	34	Apr. 17	36	36½
Nov. 26	38	38	Jan. 12	34½	34½	Mar. 1	34	34	Apr. 18	38	38½
Nov. 27	38	37½	Jan. 13	34½	35	Mar. 2	34	34	Apr. 19	38	38
Nov. 28	36½	36	Jan. 14	35	35	Mar. 3	34	34	Apr. 20	38	38
Nov. 29	35	36	Jan. 15	35	35	Mar. 4	34	34	Apr. 21	38	38
Nov. 30	35	35½	Jan. 16	34½	35	Mar. 5	34	34	Apr. 22	39	41
Dec. 1	36	36	Jan. 17	35	35	Mar. 6	34	34	Apr. 23	41	41
Dec. 2	35	35	Jan. 18	35	35	Mar. 7	34	34	Apr. 24	39	40
Dec. 3	34½	35	Jan. 19	34½	35	Mar. 8	34	34	Apr. 25	38½	38½
Dec. 4	36	35	Jan. 20	35	35	Mar. 9	34	34	Apr. 26	38½	39
Dec. 5	35½	36	Jan. 21	35	35	Mar. 10	34	34	Apr. 27	38½	39
Dec. 6	36	34½	Jan. 22	34½	34½	Mar. 11	34	34	Apr. 28	39	40
Dec. 7	35	35	Jan. 23	34½	35	Mar. 12	34	34	Apr. 29	40	40
Dec. 8	34	34½	Jan. 24	35	35	Mar. 13	34	34	Apr. 30	40	40½
Dec. 9	35	35	Jan. 25	35	35	Mar. 14	34	34	May 1	40	40
Dec. 10	35½	35½	Jan. 26	34½	35	Mar. 15	34	34	May 2	40	40
Dec. 11	36	35½	Jan. 27	35	35	Mar. 16	34	34	May 3	40	40½
Dec. 12	34	35	Jan. 28	34½	35	Mar. 17	34	34	May 4	40	40½
Dec. 13	34½	35	Jan. 29	35	35	Mar. 18	34	34	May 5	40	41
Dec. 14	35	35	Jan. 30	35	35	Mar. 19	34	34	May 6	41	41
Dec. 15	34½	35	Jan. 31	35	35	Mar. 20	34	34	May 7	42	42
Dec. 16	35½	35	Feb. 1	34½	34½	Mar. 21	34	34	May 8	43	43
Dec. 17	35	35	Feb. 2	35	35	Mar. 22	34	34	May 9	44	44½
Dec. 18	35	35	Feb. 3	34½	34½	Mar. 23	34	34	May 10	43	44
Dec. 19	34½	35	Feb. 4	34	34½	Mar. 24	34	34	May 11	43	44
Dec. 20	35	35½	Feb. 5	35	35	Mar. 25	34	34	May 12	43	43½
Dec. 21	34	34	Feb. 6	35	35	Mar. 26	34	34	May 13	43	43½
Dec. 22	34½	34	Feb. 7	35	35	Mar. 27	34	34	May 14	43	44
Dec. 23	35	35	Feb. 8	35	35	Mar. 28	34	34	May 15	43	44
Dec. 24	35	35	Feb. 9	35	35	Mar. 29	34	34	May 16	43	44
Dec. 25	35	35	Feb. 10	35	34½	Mar. 30	34	34			
Dec. 26	35	35	Feb. 11	34½	34	Mar. 31	34	34			
Dec. 27	35	35	Feb. 12	34½	34½	Apr. 1	34	34			

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[NOTE.—The references are to page-figures in brackets.]

XXIX.—REPORT OF OPERATIONS AT THE SALMON-BREEDING STATION OF THE UNITED STATES FISH COMMISSION ON THE M'CLOUD RIVER, CALIFORNIA, DURING THE SEASON OF 1882.

By Livingston Stone.

Some apprehensions were felt at the close of the last season lest there should be a recurrence of the high water which proved so disastrous to this station last year. It is true the buildings are all above the danger mark of the rising water, but, nevertheless, such high water as occurred here in the winter of 1880–'81 would do a good deal of damage to roads and trails and flumes, even if the buildings were left uninjured. As it happened, however, the rise in the river was very slight, and no injury whatever resulted to anything connected with the station.

It was my expectation to return to the McCloud River as early as June, but Congress not making the necessary appropriations until August, I did not arrive there till the first of September. In the meantime Congress had voted to extend the appropriation of the previous year for twenty days, or till July 20. On the strength of this supplementary appropriation, I had been authorized to have such preparatory work done as was necessary for putting things in readiness for the season's campaign. This enabled us to labor on the wheel and bridge, and when the appropriation was finally made, the work was so far along that our preparations for taking eggs were easily finished by the time the spawning season was fairly inaugurated.

When I arrived at the fishery, everything in the hatching-house was in readiness to receive the eggs, the seining ground was cleared, the spawning shanty built, the McCloud River bridged over and fenced against the salmon, and our great 32-foot current wheel in place and raising its 20,000 gallons of water per hour into the hatching-troughs. The credit of keeping the fishery property in such good condition during my absence is due to Mr. Robert Radcliff, whom I had left in charge the previous October, and the credit of conducting the preparatory work for the season's operations so thoroughly is due to Mr. George B. Williams, jr., who took the management of the work on the 1st of July.

On the 2d of September we made a trial haul of salmon to ascertain what condition they were in. We caught twenty-five ripe females, and I decided to begin taking eggs the next day. The next day we began collecting eggs, and continued at it, Sundays excepted, until September 25, at which time we had over 4,000,000 in the hatching-house.

My instructions directed me to take three or four million eggs only, and to give them, when taken, to the California fish commission, to be hatched out by them for the benefit of the Sacramento River.

Allow me to say here that one of the last official acts of the late Hon. B. B. Redding, as California fish commissioner, before he died, was to write a letter to Professor Baird in regard to this station, in which he stated that several hundred thousand dollars had been invested in canneries on the Sacramento River, that 1,600 men were employed in these canneries, and that this capital and these men would be ultimately thrown out of employment if the salmon hatching at this station should be given up. He also stated that the hatching of salmon here had increased the annual salmon catch of the Sacramento 5,000,000 pounds a year, and that the canneries on the river were dependent upon the salmon hatching of this station for their maintenance.

It was fortunate that no more than three or four million eggs were wanted this season, for the breeding salmon were extremely scarce, and with the utmost exertions we could not average over a quarter of a million eggs a day. It would probably have been impossible to take the eight or nine million that we have taken during previous seasons.

As a partial compensation for the numerical deficiency of the fish, they exceeded in weight the breeders of any previous season, the average weight of the females after spawning being 14 pounds. I think that we found the largest spawning female salmon this season that we have ever taken eggs from. This one weighed 23½ pounds after the eggs were taken from her, making her entire weight with the eggs upwards of 27 pounds.

The Indians this year have been very friendly, and those that we have employed have worked well. Twice, when the seine got snagged in deep water, it would have been almost impossible for us to have freed it without Indian help. On each occasion they dove for the net and released it, the water being quite deep and at the time almost like ice water.

An Indian named Jeff Davis freed the net both times, I believe. He is a very bright Indian, and he amused us very much by one of his remarks this fall. Many thousand pounds of dead salmon float down against our bridge in September. They are spoiled, of course, and we usually throw them over into the river below the bridge to relieve the racks of the pressure. This year I thought I would utilize them by putting them in the garden for a fertilizer. This was an entirely novel thing to the Indians, and Jeff was very much exercised about it. He said: "What you bury dead salmon in the garden for? I never heard of any one burying dead salmon. Next year you will be burying dead Injuns in the garden."

We still find the Indians' help invaluable. They are the best men we could have when work is to be done in the water or fish are to be handled.

As soon as all our season's eggs were taken they were turned over to the California State fish commission to be hatched. This was on the 25th of September. I remained at the fishery until the middle of Octo-

ber, when I went east, and left the premises again in charge of Mr. Radcliff.

Below will be found tables showing: I, the number and character of seine hauls made; II, the daily take of salmon eggs; III, air and water temperatures from November 1, 1881, to October 1, 1882; IV, the results of 12 experiments conducted with salmon eggs; and V, a catalogue of birds' nests and eggs collected on the McCloud River in the spring and early summer of 1882.

I.—*Record of seining operations conducted at the salmon-breeding station on the McCloud River, California, from September* 2, 1882, *to September* 25, 1882, *on account of the United States, by Livingston Stone.*

Date.	Hour.	Temperature of— Air.	Temperature of— Surface-water.	Fish taken. Males.	Fish taken. Females.	Ripe fish. Males.	Ripe fish. Females.
Sept. 2	3.00 p.m	92	56	35	12	35	3
2	4.30 p.m	80	56	20	8	20	0
2	5.15 p.m	72	56	75	29	75	10
2	5.45 p.m	70	56	50	29	50	9
2	7.00 p.m	62	56	200	95	200	20
2	8.30 p.m	58	55	100	45	100	11
2	9 25 p.m	57	55	40	22	40	6
3	5.00 a.m	57	55	30	4	30	0
3	5.35 a.m	48	50	40	20	40	5
3	7.30 a.m	49	50	4	4	4	2
3	9.30 a.m	52	50	25	14	25	4
3	6.30 p.m	68	56	15	6	15	2
3	7.00 p.m	63	54	0	0	0	0
3	7.40 p.m	60	54	40	18	40	8
3	8.40 p.m	56	53	8	6	8	2
3	10.00 p.m	53	53	25	11	25	3
4	5.30 a.m	48	50	30	20	30	6
4	5.50 a.m	42	50	110	41	110	11
4	6.30 a.m	42	50	2	0	2	0
4	7.40 a.m	63	52	30	17	30	7
4	9.00 a.m	68	54	50	13	50	3
4	7.30 p.m	70	50	25	9	25	3
4	9.00 p.m	60	50	75	40	75	13
4	9.25 p.m	52	55	30	12	30	3
5	5.30 a.m	52	50	15	9	15	5
5	6.00 a.m	50	50	20	13	20	5
5	6.50 a.m	40	50	50	36	50	14
5	7.50 a m	50	50	15	0	15	0
5	9.30 a.m	62	50	17	2	17	2
5	4.00 p.m	90	58	8	0	8	0
5	7.45 p.m	60	54	14	2	14	2
5	8.15 p.m	60	54	14	4	14	3
5	8.30 p.m	56	52	16	4	16	2
5	9.15 p.m	56	51	25	9	25	5
5	10.00 p.m	54	50	28	12	28	4
6	5.10 a.m	50	50	18	14	18	5
6	6.00 a.m	50	50	18	9	18	6
6	6.30 a.m	52	50	20	10	20	5
6	8.00 a.m	60	52	32	24	32	11
6	9.15 a.m	70	52	20	6	20	2
6	10.00 a.m	76	50	14	2	14	2
6	4.15 p.m	80	52	24	5	24	2
6	5.00 p.m	72	53	50	50	50	25
6	5.20 p.m	66	53	12	6	12	1
6	7.00 p.m	66	54	25	23	25	11
6	8.30 p.m	58	54	20	6	20	0
6	9.20 p.m	56	54	20	10	20	4
7	5.15 a.m	42	50	30	18	30	8
7	5.35 a.m	42	50	35	27	35	13
7	6.00 a.m	50	50	18	12	18	5
7	7.35 a.m	50	50	12	5	12	2
7	7.55 a.m	50	52	20	22	20	8
7	9.15 a.m	70	50	24	8	24	0
7	9.35 a.m	70	50	26	3	26	0
7	4.15 p.m	88	56	12	4	12	3
7	4.55 p.m	78	56	8	4	8	4
7	6.00 p.m	70	54	28	8	28	8
7	6.15 p.m	64	54	8	1	8	0
7	7.10 p m	60	53	40	20	40	8
7	7.50 p.m	60	52	32	12	32	4
7	8.30 p.m	60	52	38	17	38	5

I.—*Seining operations conducted at salmon-breeding station on McCloud River, &c.*—Cont'd.

Date.		Hour.	Temperature of— Air.	Temperature of— Surface-water.	Fish taken. Males.	Fish taken. Females.	Ripe fish. Males.	Ripe fish. Females.
Sept.	7	9.15 p. m	58	51	10	4	10	6
	7	10.00 p. m	56	51	25	16	25	12
	8	5.00 a. m	46	50	30	36	30	7
	8	5.20 a. m	46	50	14	25	14	17
	8	5.50 a. m	47	50	24	33	24	3
	8	6.20 a. m	48	50	8	5	8	0
	8	7.35 a. m	50	50	6	1	6	1
	8	9.22 a. m	70	50	50	25	50	13
	8	10.10 a. m	72	50	8	2	8	0
	8	6.35 p. m	66	54	30	18	30	6
	8	6.55 p. m	60	52	35	16	35	10
	8	7.30 p. m	60	52	22	14	22	8
	8	8.10 p. m	60	52	12	2	12	1
	8	8.50 p. m	56	52	4	1	4	0
	8	9.50 p. m	54	52	15	17	15	6
	9	5.15 a. m	42	50	12	7	12	5
	9	5.35 a. m	42	50	26	25	26	22
	9	6.15 a. m	40	50	20	17	20	12
	9	6.40 a. m	52	50	22	11	22	7
	9	8.10 a. m	60	50	10	4	10	2
	11	5.00 a. m	40	50	26	26	26	14
	11	5.30 a. m	46	50	24	33	24	15
	11	6.10 a. m	46	50	40	59	40	39
	11	7.30 a. m	58	50	24	26	24	12
	11	9.15 a. m	60	50	50	29	50	11
	11	4.45 p. m	84	54	75	7	75	3
	11	6.20 p. m	68	52	14	15	14	7
	11	7.20 p. m	66	52	40	7	40	4
	11	8.05 p. m	62	52	14	7	14	3
	11	8.55 p. m	60	50	40	7	40	3
	11	9.45 p. m	60	50	14	7	14	3
	12	5.00 a. m	50	50	12	28	12	16
	12	5.30 a. m	50	50	8	8	8	3
	12	6.10 a. m	50	50	6	7	6	3
	12	7.45 a. m	55	52	12	11	12	6
	12	8.00 a. m	60	52	6	3	6	1
	12	9.25 a. m	70	53	10	7	10	4
	12	5.00 p. m	80	54	8	6	8	3
	12	7.05 p. m	76	54	8	5	8	1
	12	7.35 p. m	66	52	16	13	16	7
	12	8.15 p. m	60	52	24	19	24	10
	12	9.00 p. m	58	52	18	10	18	6
	12	10.05 p. m	56	52	10	6	10	2
	13	5.15 a. m	48	50	10	14	10	11
	13	5.50 a. m	49	50	24	36	24	24
	13	6.40 a. m	54	50	26	20	26	9
	13	8.00 a. m	62	50	32	38	32	16
	13	8.15 a. m	64	50	10	2	10	0
	13	9.50 a. m	70	50	25	15	25	5
	13	4.50 p. m	94	54	14	11	14	5
	13	7.15 p. m	66	54	12	10	12	6
	13	8.00 p. m	62	53	6	3	6	1
	13	8.25 p. m	60	53	9	9	9	5
	13	9.00 p. m	60	52	6	0	6	0
	13	9.55 p. m	58	52	12	9	12	5
	14	5.05 a. m	48	50	12	20	12	10
	14	5.35 a. m	48	50	8	10	8	7
	14	6.05 a. m	44	50	8	9	8	6
	14	6.30 a. m	46	50	9	7	9	6
	14	7.50 a. m	50	50	10	1	10	....
	14	8.00 a. m	50	50	12	4	12	3
	14	9.30 a. m	64	50	24	8	24	4
	14	6.05 p. m	84	54	12	9	12	....
	14	6.20 p. m	70	54	16	8	16	5
	14	7.10 p. m	84	54	....	....	....	5
	14	8.00 p. m	84	52	8	7	8	....
	14	9.00 p. m	84	52	3	3	3	1
	15	5.50 a. m	56	52	5	17	5	14
	15	6.10 a. m	54	52	10	7	10	5
	15	6.25 a. m	54	52	12	6	12	2
	15	7.55 a. m	56	52	8	7	8	4
	15	8.10 a. m	56	52	8	2	8	2
	15	9.40 a. m	58	52	9	3	9	3
	15	10.15 a. m	60	52	10	....	10	....
	15	11.00 a. m	60	52	12	2	12	2
	15	6.35 p. m	58	52	24	7	24	7
	15	7.00 p. m	58	52	12	6	12	6
	15	7.50 p. m	54	52	16	1	16	1
	15	8.50 p. m	52	52	8	14	8	4

I.—*Seining operations conducted at salmon-breeding station on McCloud River, &c.*—Cont'd.

Date.	Hour.	Temperature of— Air.	Temperature of— Surface-water.	Fish taken. Males.	Fish taken. Females.	Ripe fish. Males.	Ripe fish. Females.
Sept. 15	9.50 p. m	52	52	8	12	8	4
16	5.30 a. m	50	50	3	22	3	14
16	5.50 a. m	42	50	7	17	7	7
16	7.15 a. m	40	50	5	12	5	7
16	7.40 a. m	40	50	14	32	14	20
16	7.55 a. m	42	50	12	19	12	11
16	5.50 p. m	65	50	4	11	4	5
18	6.15 a. m	44	50	8	20	8	12
18	3.35 a. m	46	50	4	13	4	7
18	7.30 a. m	46	50	26	2	26	....
18	8.10 a. m	46	50	7	....	7	....
18	8.40 a. m	48	50	5	7	5	5
18	10.15 a. m	51	50	16	....	16	....
18	6.45 p. m	58	52	6	6	6	2
18	7.00 p. m	58	52	10	3	10	3
18	7.45 p. m	56	52	2	2	2	2
18	8.35 p. m	54	52	2	5	2	5
18	9.30 p. m	54	52	2	2	2	2
18	10.20 p. m	48	52	....	1	....	1
19	5.00 a. m	48	50	2	7	2	7
19	5.30 a. m	48	50	1	8	1	8
19	6.05 a. m	50	50	10	4	10	4
19	6.45 a. m	54	50	5	1	5	1
19	8 15 a. m	58	50	10	1	10	1
19	8.45 a. m	60	52	10	1	10	1
19	6.20 p. m	66	52	8	8	8	8
19	6.35 p. m	62	52	....	2	....	2
19	7.10 p. m	62	52	7	5	7	5
19	8.00 p. m	60	52	2	2	2	2
19	8.45 p. m	58	52	....	....	....	....
10	9.45 p. m	54	52	....	3	....	3
20	4.45 a. m	46	50	2	12	2	12
20	5.15 a. m	48	50	1	3	1	3
20	5.45 a. m	48	50	4	8	4	8
20	6.15 a. m	48	50	4	4	4	4
20	7.30 a. m	48	50	4	....	4	....
20	7.45 a. m	48	50	12	2	12	2
20	6.00 p. m	66	52	2	....	2	....
20	6.15 p. m	64	52	2	....	2	....
20	7.00 p. m	62	52	2	1	2	1
20	7.35 p. m	58	52	....	1	....	1
21	3.45 a. m	48	50	3	3	3	3
21	4.05 a. m	48	50	....	2	....	2
20	4.50 a. m	48	50	1	2	1	2
21	5.30 a. m	48	50	6	8	6	8
21	5.50 a. m	48	50	5	1	5	1
21	6.30 a. m	46	50	12	2	12	2
21	7.40 a. m	48	50	12	5	12	5
21	8.15 a. m	54	50	10	....	10	....
21	6.45 p. m	62	52	3	2	3	2
21	7.30 p. m	62	52	3	2	3	2
21	8.30 p. m	58	52	2	2	2	2
24	9.00 p. m	52	52	....	5	....	5
22	3.45 a. m	44	50	2	1	2	1
22	4.10 a. m	42	50	1	1	1	1
22	5.00 a. m	42	50	....	6	....	6
22	5.40 a. m	42	50	8	6	8	6
22	6.20 a. m	42	50	10	2	10	2
22	8.00 a. m	50	50	7	1	7	1
22	8.35 a. m	58	50	8	1	8	1
22	7.20 p. m	60	53	1	1	1	1
22	8.00 p. m	56	52	1	4	1	4
22	9.00 p. m	56	52	....	1	....	1
23	3.40 a. m	42	50	3	2	3	2
23	4.20 a. m	44	50	1	4	1	4
23	5.00 a. m	44	50	2	....	2	....
23	5.35 a. m	42	50	....	....	....	....
23	6.35 a. m	40	50	3	3	3	3
23	8.00 a. m	52	50	6	1	6	1
23	8.30 a. m	62	50	3	....	3	....
23	8.00 p. m	60	52	....	....	....	....
23	8.25 p. m	56	52	2	....	2	....
23	8.45 p. m	54	52	1	....	1	....
24	6.00 a. m	40	50	1	1	1	1
24	6.30 a. m	40	48	3	3	3	3

NOTE.—The condition of sky and water was reported "clear" from September 3, 3.00 p. m, till September 7, 9.15 a. m., after which there were no reports.

II.—*Daily record of salmon eggs taken at the United States salmon-breeding station on the McCloud River, California, during the season of* 1882.

Date.	Number of female salmon spawned.	Number of eggs taken.	Date.	Number of female salmon spawned.	Number of eggs taken.
September 3	17	78, 800	September 15	45	161, 100
4	86	327, 350	16	62	255, 600
5	36	185, 400	18	44	175, 500
6	86	335, 900	19	27	111, 700
7	40	154, 700	20	31	127, 500
8	88	356, 150	21	30	129, 200
9	53	204, 850	22	28	134, 600
11	100	372, 100	24	29	121, 800
12	52	177, 400			
13	101	379, 200		999	3, 991, 750
14	44	202, 900			
Average number of eggs to each fish					3, 995

To this total of the eggs regularly taken are to be added 80,300 taken for purposes of experiment, making a grand total of 4,072,050 eggs as the result of the season's operations.

III.—*Table of temperatures taken at the United States salmon-breeding station, McCloud River, California, during the season of* 1882.

Month.	Air.				Water.			Weather.
	Shade.			Sun.				
	7 A. M.	3 P. M.	7 P. M.	3 P. M.	7 A. M.	3 P. M.	7 P. M.	
Nov. 1	44	72	....	78	44	48	....	Clear.
2	46	74	54	80	45	48	47	Do.
3	38	73	54	80	44	48	47	Clear a. m; Cloudy p. m.
4	42	73	56	80	44	48	46	Do.
5	40	70	60	72	45	48	47	Cloudy.
6	40	68	54	72	45	48	46	Do.
7	34	60	48	72	44	47	45	Clear.
8	32	70	46	73	43	45	45	Do.
9	32	65	42	70	42	44	44	Do.
10	38	70	50	66	43	46	45	Do.
11	36	68	50	75	43	45	45	Do.
12	35	42	50	73	43	48	45	Do.
13	48	66	53	68	45	47	46	Cloudy.
14	54	56	53	....	46	49	46	Rain.
15	38	57	48	....	46	47	45	Do.
16	35	56	40	....	44	44	43	Do.
17	32	57	44	....	43	45	46	Do.
18	25	57	45	....	42	45	44	Clear.
19	36	70	46	84	42	45	42	Do.
20	34	70	50	73	42	45	44	Do.
21	48	70	50	68	42	46	43	Do.
22	45	70	50	90	42	44	44	Do.
23	38	74	46	76	42	42	43	Do.
24	36	70	50	76	42	46	44	Do.
25	38	72	50	78	43	46	44	Do.
26	34	66	52	64	42	44	44	Do.
27	41	62	54	60	44	44	45	Cloudy
28	50	60	50	62	46	46	46	Do.
29	38	64	50	74	44	46	44	Clear.
30	36	64	42	62	42	42	44	Rain.
Dec. 1	37	70	44	75	42	42	43	Clear.
2	34	50	46	52	44	44	44	Cloudy.
3	34	50	46	52	43	44	44	Do.
4	42	46	45	46	43	43	43	Rain.
5	58	56	60	60	44	47	47	Do.
6	52	60	54	62	47	50	47	Do.
7	46	64	50	70	46	47	45	Clear.

III.—*Table of temperatures taken at the salmon-breeding station, McCloud River, &c.*—Cont'd.

Month.		Air.				Water.			Weather.
		Shade.			Sun.				
		7 A. M.	3 P. M.	7 P. M.	3 P. M.	7 A. M.	3 P. M.	7 P. M.	
Dec.	8	38	62	45	64	44	46	44	Clear.
	9	34	60	48	70	42	44	44	Do.
	10	44	52	45	52	44	44	43	Rain.
	11	34	48	48	50	42	48	44	Cloudy.
	12	37	52	44	52	43	46	44	Do.
	13	36	62	46	74	42	46	43	Clear.
	14	32	60	46	62	42	44	45	Do.
	15	40	52	45	52	43	44	44	Rain.
	16	34	60	60	70	42	46	44	Clear.
	17	36	62	54	70	41	44	44	Do.
	18	48	72	50	72	44	44	44	Do.
	19	48	64	45	78	43	46	44	Do.
	20	....	....	....	....	....	....	....	
	21	....	....	....	....	....	....	....	
	22	32	60	48	72	42	44	42	Clear.
	23	36	64	....	76	44	44	44	Do.
	24	36	52	....	54	43	44	44	Do
	25	34	47	....	52	42	44	....	
	26	36	44	....	....	42	43	38	Snow.
	27	50	40	....	....	40	44	42	Rain.
	28	46	52	....	....	41	42	44	Cloudy.
	29	38	66	....	82	42	46	44	Clear.
	30	38	62	....	66	42	44	43	Do.
	31	36	62	....	76	42	44	43	Do.
1882. Jan.	1	44	54	46	60	43	44	43	Clear.
	2	46	54	50	....	44	44	44	Rain.
	3	50	60	58	....	45	46	44	Do.
	4	52	54	44	....	46	45	45	Do.
	5	50	62	52	....	45	46	46	Do.
	6	42	54	42	60	46	45	44	Clear.
	7	32	50	40	62	41	44	44	Do.
	8	30	52	41	72	41	45	42	Do.
	9	32	60	40	76	42	44	42	Do.
	10	32	54	38	56	41	43	42	Do
	11	36	52	38	56	40	43	41	Do.
	12	26	52	38	60	40	42	42	Do.
	13	26	56	40	70	39	42	42	Do.
	14	38	62	44	74	40	44	42	Do.
	15	36	52	44	70	40	44	42	Do.
	16	37	62	54	76	40	44	42	Do.
	17	30	62	50	70	40	44	43	Do.
	18	32	58	45	70	41	44	42	Do.
	19	32	60	44	80	40	42	42	Do.
	20	32	60	44	70	40	44	42	Do.
	21	30	58	44	62	40	42	41	Cloudy.
	22	34	48	46	50	40	42	42	Do.
	23	40	46	42	50	42	44	42	Rain.
	24	40	44	40	....	42	42	41	Do.
	25	40	40	40	....	42	44	41	Do.
	26	42	44	38	....	42	43	41	Do.
	27	30	46	34	60	41	44	41	Do.
	28	31	54	38	74	40	44	41	Clear.
	29	30	50	32	58	40	44	40	Do.
	30	28	52	42	60	40	42	41	Do.
	31	35	52	42	70	40	44	41	Do.
Feb.	1	30	56	46	86	40	44	41	Do.
	2	38	70	44	82	40	42	41	Do.
	3	28	68	44	80	40	44	41	Do.
	4	29	68	50	84	40	44	41	Do.
	5	30	50	40	60	41	44	42	Do.
	6	29	52	36	70	40	44	42	Do.
	7	36	56	38	72	40	42	42	Do.
	8	36	50	40	....	41	42	43	Do.
	9	38	52	52	....	42	44	44	Rain.
	10	40	52	41	64	43	42	42	Clear.
	11	32	46	38	50	42	44	42	Cloudy.
	12	34	40	40	40	42	42	42	Snow, 4 inches.
	13	30	50	38	62	41	44	42	Clear.
	14	60	66	....	92	41	46	44	Do.
	15	40	62	40	70	41	44	42	Do.
	16	30	38	40	....	43	42	41	Snow.
	17	32	42	40	64	44	44	41	Clear.
	18	32	42	40	74	44	44	42	Do.
	19	28	50	40	70	39	42	42	Do.

III.—*Table of temperatures taken at salmon-breeding station, McCloud River, &c.*—Cont'd.

Month.		Air. Shade. 7 A. M.	Air. Shade. 3 P. M.	Air. Shade. 7 P. M.	Air. Sun. 3 P. M.	Water. 7 A. M.	Water. 3 P. M.	Water. 7 P. M.	Weather.
Feb.	20	50	62	42	68	42	44	42	Clear.
	21	46	66	46	70	42	44	43	Do.
	22	36	52	46	....	42	42	44	Cloudy.
	23	46	46	48	....	45	44	46	Rain.
	24	45	48	50	....	46	46	46	Do.
	25	46	58	50	....	46	52	46	Do.
	26	46	58	49	....	46	46	46	Do.
	27	46	50	48	....	46	46	46	Do.
	28	46	50	48	....	45	52	47	Do.
Mar.	1	46	56	56	60	47	48	48	Do.
	2	36	46	50	....	46	46	48	Do.
	3	32	52	40	58	44	44	44	Clear.
	4	38	52	46	54	44	46	44	Do.
	5	32	54	40	82	44	46	44	Do.
	6	28	60	46	76	42	46	44	Do.
	7	34	66	52	78	42	46	45	Do.
	8	34	58	46	78	42	46	45	Do.
	9	28	52	44	52	42	44	44	Do.
	10	30	44	41	48	42	45	44	Snow.
	11	34	60	44	80	42	45	45	Clear.
	12	36	67	46	82	43	46	45	Do.
	13	42	50	45	....	44	46	45	Rain.
	14	40	50	42	....	44	46	43	Do.
	15	36	44	44	....	43	44	43	Snow.
	16	38	46	42	62	44	46	45	Clear.
	17	37	50	40	....	44	46	46	Rain.
	18	38	50	42	55	44	46	46	Clear.
	19	38	50	42	52	44	46	46	Do.
	20	32	62	44	90	44	46	47	Do.
	21	36	72	....	97	44	46	....	Do.
	22	44	80	61	100	46	50	50	Do.
	23	45	82	62	102	46	50	50	Do.
	24	46	82	63	94	46	50	50	Do.
	25	44	72	....	....	48	50	....	Do.
	26	....	....	....	96	....	50	....	Do.
	27	44	80	....	114	48	50	....	Do.
	28	46	82	70	94	48	50	70	Do.
	29	46	86	50	100	48	50	50	Do.
	30	52	88	....	100	48	50	....	Do.
	31	....	82	....	96	....	52	....	Do.
Apr.	1	....	76	....	90	....	52	....	Do.
	2	50	72	76	82	52	50	52	Do.
	3	46	58	56	60	50	52	52	Cloudy.
	4	44	74	58	90	50	52	54	Clear.
	5	54	54	....	60	50	52	....	Rain.
	6	....	56	....	86	....	50	....	Clear.
	7	32	64	45	70	44	50	52	Do.
	8	....	....	....	64	....	46	....	Rain.
	9	....	48	46	64	....	46	52	Do.
	10	42	56	50	72	44	52	52	Clear.
	11	46	62	52	80	50	52	50	Do.
	12	46	72	58	96	50	52	52	Do.
	13	....	78	....	94	....	54	54	Do.
	14	48	80	....	100	52	54	....	Do.
	15	....	68	....	94	....	54	....	Do.
	16	....	62	54	94	....	54	52	Do.
	17	....	68	58	90	....	52	50	Do.
	18	44	68	64	78	50	52	52	Do.
	19	....	58	50	68	....	54	52	Do.
	20	36	60	52	76	44	50	46	Do.
	21	52	62	56	64	42	46	50	Do.
	22	50	56	46	76	42	46	40	Do.
	23	....	52	48	64	....	42	40	Do.
	24	36	62	54	82	44	48	48	Do.
	25	34	72	64	92	46	48	50	Do.
	26	50	74	64	98	50	52	52	Do.
	27	52	84	66	100	50	52	52	Do.
	28	50	88	70	104	50	54	52	Do.
	29	64	82	66	100	52	54	52	Do.
	30	56	72	66	74	52	54	52	
May	1	56	72	66	74	52	54	52	Do.
	2	54	56	52	70	50	50	50	Rain.
	3	52	54	52	70	48	48	46	Do.
	4	50	62	52	80	48	46	46	Clear.
	5	42	72	62	96	44	46	46	Do.
	6	48	72	62	102	46	48	48	Do.
	7	....	....	....	....	....	....	....	Do.

III.—*Table of temperatures taken at salmon-breeding station, McLoud River, &c*—Cont'd.

Month.	Air.				Water.			Weather.
	Shade.			Sun.				
	7 A. M.	3 P. M.	7 P. M.	3 P. M.	7 A. M.	3 P. M.	7 P. M.	
May 8	....	....	....	....	....	....	....	Clear.
9	....	....	64	....	....	....	....	Do.
10	54	84	70	92	46	52	48	Do.
11	58	76	66	90	52	52	52	Do.
12	46	60	52	94	44	50	46	Do.
13	38	60	54	64	42	44	44	Do.
14	38	64	54	78	44	44	46	Do.
15	42	62	60	66	44	46	46	Do.
16	42	68	60	98	46	50	50	Do.
17	44	80	64	102	50	52	52	Do.
18	52	82	66	104	50	52	52	Do.
19	58	80	72	108	50	52	52	Do.
20	54	86	70	100	52	52	52	Do.
21	46	88	....	104	52	54	....	Do.
22	56	80	68	98	52	54	54	Do.
23	50	72	64	78	52	52	52	Do.
24	50	64	64	100	52	52	54	Do.
25	54	64	60	100	46	50	50	Rain.
26	50	82	64	106	42	52	54	Clear.
27	56	88	60	....	42	54	52	Do.
28	62	88	70	104	52	54	56	Do.
29	62	90	74	102	54	56	54	Do.
30	62	92	78	102	52	56	56	Do.
31	66	96	....	102	54	54	....	Do.
June 1	58	98	84	120	48	60	56	Do.
2	60	94	82	120	....	56	56	Do.
3	54	88	76	110	54	56	56	Do.
4	58	86	76	104	54	56	56	Do.
5	56	78	72	94	54	56	54	Do.
6	56	72	70	80	52	54	54	Do.
7	56	72	72	94	52	56	56	Do.
8	54	74	70	96	52	56	56	Do.
9	58	76	74	100	54	54	56	Do.
10	54	86	78	110	52	54	56	Do.
11	60	86	80	100	54	52	58	Do.
12	60	84	72	100	52	56	56	Do.
13	60	84	72	110	52	56	54	Do.
14	....	86	74	104	....	54	54	Do.
15	72	90	....	104	54	58	....	Do.
16	68	96	82	120	54	58	58	Do.
17	72	94	80	122	58	60	58	Do.
18	72	92	....	122	56	54	....	Do.
19	64	76	68	110	54	58	56	Do.
20	56	76	70	108	54	56	54	Do.
21	56	80	70	108	52	56	52	Do.
June 22	58	80	58	108	52	58	56	Clear.
23	56	82	74	86	54	54	56	Do.
24	....	80	72	96	....	58	56	Do.
25	60	84	72	106	54	58	56	Do.
26	58	84	74	102	54	60	58	Do.
27	56	82	72	102	54	60	58	Do.
28	52	88	76	108	54	58	58	Do.
29	58	92	....	108	52	58	....	Do.
30	58	98	84	102	54	62	60	Do.
July 1	66	98	79	117	58	62	60	Do.
2	67	98	80	120	58	62	60	Do.
3	64	104	86	122	58	63	61	Do.
4	60	94	80	110	58	62	60	Do.
5	60	96	81	116	51	62	60	Do.
6	60	97	80	117	56	60	60	Do.
7	59	99	79	116	57	60	59	Do.
8	59	90	77	118	56	58	57	Do.
9	60	96	78	128	56	59	57	Do.
10	68	98	80	122	57	60	58	Do.
11	70	104	78	128	57	61	59	Do.
12	67	100	77	120	56	60	59	Do.
13	69	101	76	122	57	60	58	Do.
14	72	101	80	126	57	61	59	Do.
15	71	98	80	115	57	60	58	Do.
16	72	93	76	110	56	60	58	Do.
17	58	96	75	122	56	60	58	Do.
18	70	99	86	120	56	60	59	Partially cloudy.
19	67	90	82	114	57	60	58	
20	69	93	72	110	57	59	58	Cloudy; showers.
21	60	80	67	100	56	58	58	Cloudy.
22	62	94	76	108	57	59	58	Clear.
23	62	82	78	100	57	59	58	Do.

III.—*Table of temperatures taken at salmon-breeding station, McLoud River, &c*—Cont'd.

Month.	Air.				Water.			Weather.
	Shade.			Sun.				
	7 A. M.	3 P. M.	7 P. M.	3 P. M.	7 A. M.	3 P. M.	7 P. M.	
May 24	54	92	74	112	56	59	58	Clear.
25	56	90	70	110	55	59	58	Do.
26	54	96	78	114	56	59	58	Do.
27	60	94	77	122	56	59	58	Do.
28	70	95	78	120	56	59	58	Do.
29	56	96	76	115	55	59	58	Do.
30	60	90	72	106	56	59	58	Do.
31	56	84	78	99	57	59	58	Do.
Aug. 1	62	86	76	100	56	59	58	Do.
2	64	92	80	110	56	59	58	Do.
3	58	90	78	108	56	59	58	Do.
4	60	94	80	112	56	59	58	Do.
5	66	92	76	118	57	59	58	Do.
6	58	90	78	110	56	59	58	Do.
7	45	90	76	108	54	57	56	Do.
8	60	98	78	112	55	58	57	Do.
9	62	102	80	128	56	59	58	Do.
10	67	103	82	129	56	59	57	Do.
11	70	102	84	120	55	58	56	Do.
12	60	103	80	128	54	59	58	Do.
13	53	90	80	110	54	58	57	Do.
14	54	92	79	121	54	59	58	Do.
15	60	96	79	118	55	58	57	Do.
16	55	88	74	108	55	57	56	Do.
17	48	88	78	110	54	57	56	Do.
18	54	96	76	116	55	58	57	Do.
19	50	92	74	118	54	57	56	Do.
20	48	94	76	120	54	57	56	Do.
21	56	96	77	118	55	58	57	Do.
22	52	98	78	120	55	58	57	Do.
23	57	96	76	118	55	59	58	Do.
24	54	97	78	114	55	58	57	Do.
25	60	98	76	116	55	59	57	Do.
26	58	90	74	110	56	58	56	Do.
27	50	90	70	118	54	57	56	Do.
28	48	98	76	120	54	58	57	Do.
29	50	102	78	120	55	58	57	Do.
30	48	99	80	118	54	58	57	Do.
31	50	101	78	119	55	58	57	Do.
Sept. 1	52	92	74	106	54	56	54	Very smoky.
2	54	93	72	108	54	56	54	Do.
3	49	92	70	110	54	55	54	Clear.
4	50	92	71	112	53	55	54	Do.
5	48	92	....	106	53	56	55	Do.
6	49	93	70	109	54	56	55	Do.
7	50	90	71	106	54	56	56	Do.
8	51	90	70	107	52	56	55	Do.
9	50	90	71	106	53	56	55	Do.
10	50	90	70	108	53	56	54	Do.
11	50	92	73	112	53	56	55	Do.
12	51	94	71	119	52	57	56	Do.
13	50	93	70	115	52	56	55	Do.
14	49	89	82	106	53	56	56	Signs of rain.
15	60	64	61	84	54	54	53	Showers at night.
16	47	62	56	....	50	52	51	Cloudy; slight showers.
17	52	54	52	....	60	52	51	Cloudy and rain.
18	50	69	58	90	50	52	51	Clear.
19	54	86	68	110	50	54	51	Do.
20	50	88	67	111	50	55	52	Do.
21	49	90	66	115	50	55	51	Do.
22	48	93	64	115	50	54	53	Do.
23	48	92	62	112	50	55	53	Do.
24	47	94	60	116	50	55	53	Do.
25	48	86	60	107	50	54	52	Do.
26	49	89	62	110	50	55	51	Do.
27	46	86	60	105	50	54	51	Do.
28	47	85	61	106	50	54	52	Do.
29	43	87	60	105	48	53	50	Do.
30	49	85	60	100	48	53	50	Copious rain and hail.
Oct. 1	45	48	46	....	49	48	47	Do.
2	48	51	49	....	46	47	47	Do.
3	46	56	54	....	46	49	48	Cleared at noon.
4	39	60	57	....	46	49	48	Cloudy.
5	44	64	58	70	46	50	49	Cloudy and sunshine.
6	50	54	57	....	48	50	49	Cloudy.

IV.—*Experiments conducted with salmon eggs during the season of* 1882 *at the McCloud River salmon-breeding station, California.*

[In these experiments both eggs and milt were taken in a dry vessel and no water used until after impregnation was supposed to have taken place.]

No. of experiment.	Nature of experiment.	Number of eggs taken.	Number of eggs picked out.	Number of eggs impregnated.
1	Eggs allowed to remain in pan one minute before milt was put on	2, 500	338	2, 162
2	Eggs allowed to remain in pan two minutes before milt was put on.	3, 000	950	2, 048
3	Eggs allowed to remain in pan three minutes before milt was put on.	3, 600	542	3, 058
4	Milt allowed to remain in pan one minute before eggs were put in.	3, 600	923	2, 677
5	Milt allowed to remain in pan two minutes before eggs were put in.	3, 100	711	2, 389
6	Milt allowed to remain in pans three minutes before eggs were put in.	3, 000	1, 838	1, 162
7	Canada process*	25, 000	1, 360	23, 640
8	Eggs taken from dead fish	2, 500	2, 400	100
9	Eggs washed immediately after milt was added	3, 000	3, 000	(†)
10	Milt eighteen hours old when used	3, 000	3, 000	(†)
11	Milt forty-eight hours old when used	3, 000	3, 000	(†)
12	All the eggs and milt taken in a dry bucket as rapidly as possible, till the bucket was full.	25, 000	4, 151	20, 849
		80, 300	....	....

*In this experiment the eggs of six or seven salmon, one fish at a time, were taken successively in a dry pan, and as soon as impregnated, each pan of eggs was poured into a bucket of water. This, if I am rightly informed, is a method of taking salmon eggs used in Canada. Its advantage is that it saves multiplying pans, one being sufficient for a season's spawning.

† Failure.

V.—*Catalogue of birds, nests, and eggs collected on the McCloud River, California, in the spring and early summer of* 1882.

1. Linnet, nest, and one egg. Found in small oak.
2. Humming-bird, nest, and two eggs. Found in oak.
3. Dove, nest, and one egg. Found in large oak.
4. Yellow-bird, nest, and four eggs. Found in large oak.
5. Bird, nest, and two eggs. Found in small oak.
6. Bird, nest, and three eggs. Found in small oak.
7. Bird's wing, nest, and four eggs. Found in small oak, high up. Head lost. Color of wing same as head, with a little yellow spot over each eye; pointed beak.
8. Bird and nest. Found in oak.
9. Nest and four eggs. Found in a high oak.
10. Nest and four eggs. Found in scrub-oak bush.
11. Bird, nest, and one egg. Found in small oak.
12. Nest and three eggs. Found in low bush.
13. Bird, nest, and six eggs. Found in barn.
14. Bird, nest, and four eggs. Found in barn.
15. Bird, nest, and three eggs. Found in low bush.
16. Nest and three eggs. Found in small oak.
17. Nest. Found in live-oak.
18. Bird, nest, and three eggs. Found in scrub-oak.
19. Bird, nest, and five eggs. Found in bush.

20. Nest and three eggs. Found on side of house.
21. Bird, nest, and three eggs. Found on wheel-boat.
22. Two birds, nest, and three eggs. Found in bush on bank of river.
23. Bird, nest, and three eggs. Found high in large oak tree.
24. Humming-bird, nest, and two eggs. Found in large oak tree.
25. Bird, nest, and four eggs. Found on side of large rock.
26. Bird, nest, and two eggs. Found in large oak tree.
27. Bird, nest, and one egg. Found in low pine tree.
28. Bird, nest, and two eggs. Found in small oak.
29. Bird, nest, and four eggs. Found in large oak.
30. Nest and one egg. Found in low pine.
31. Humming-bird, nest, and two eggs. Found on low bush near water.
32. Bird, nest, and four eggs. Found in low bush.
33. Bird, nest, and two eggs. Found high in oak.
34. Quail and one egg. Found on ground; no nest.
35. Bird, nest, and four eggs. Found in large oak.
36. Bird, nest, and three eggs. Found in low oak.
37. Bird, nest, and one egg. Found high in oak.
38. Bird, nest, and two eggs. Found in small fir tree.
39. Bird and nest.
40. Bird, nest, and one egg. Found in oak.
41. Nest and two eggs. Found in stump of tree.
42. Bird and nest. Found in small oak tree.
43. Bird, nest, and three eggs. Found in large oak.

XXX.—REPORT OF OPERATIONS AT THE TROUT-BREEDING STATION OF THE UNITED STATES FISH COMMISSION ON THE M'CLOUD RIVER, CALIFORNIA, DURING THE YEAR 1882.

By Livingston Stone.

When my last report closed, December 31, 1881, everything was going on well at the trout ponds. There had been no recurrence of the extreme high water of last year, and, though it had been unusually cold, it had not been very rainy; and no trouble had been caused, as in the previous winter, by the heavy rains washing down mud into the creek from above.

The trout were already showing signs of preparing to cast their spawn when the year opened, and on the 5th of January the first eggs were taken, to the number of about 50,000. The taking of eggs continued till the 5th of May, when the last lot was placed in the hatching troughs. Some spawning fish were left in the ponds, but for some reason were very slow in getting ripe, and some of them did not deposit their eggs till August. The winter was very cold, and the temperature of the water in which the eggs were hatched became so low that they were twelve days longer in showing the eye-spots than they were last year. Still water, in hollow places in the rocks, froze to the thickness of eight inches, indicating a degree of cold unprecedented on the McCloud River since white men first visited it.

As has been noticed heretofore, the smaller females, presumably the youngest fish, spawned first, the larger and older ones all coming on later. Also, as in previous years, the spawning females that were bright and plump and in best condition gave the smallest eggs, other things being equal, while the thin and lean-looking gave the largest; the general rule prevailing, however, throughout, that the larger the fish, the greater the size of the eggs.

The eggs varied in size and complexion this season as much as ever, some of them being almost if not fully as large as the smaller salmon eggs, while others were not much if any larger than those of the eastern brook trout, *Salvelinus fontinalis*. The color of the eggs varied, too, as usual, ranging from the almost blood-red of the salmon eggs to a light straw color. No peculiarity about the looks of the ripe female trout could be observed that was constant, except the shape of the abdomen distended by its burden of full-grown eggs. Some of the ripe fish were black and dirty looking, others were bright and fresh looking; some

had the red band strongly marked, others had not a trace of it. Consequently one cannot tell by the looks of the trout whether it is ripe or not. To ascertain this every fish must be tried and examined separately by hand.

On the whole, the spawning season was quite successful, and over 337,000 trout eggs were taken and distributed from this station in the present year.

The eggs, after being packed, are carried on horses to the salmon-breeding station, 4 miles down the McCloud River, and from there are taken to Redding, California, 22 miles farther, by stage. From Redding they are shipped by rail for 3,000 miles or more, as the case may be, to their eastern destination. It is wonderful that any of them arrive at the end of their long journey in good order, but some lots opened at their journey's end in excellent condition, as may be seen by the following letters:

[I.—From FRANK N. CLARK, Northville, Mich., February 8, 1882.]

The eggs of California trout which you shipped from Redding on the 25th of January came to hand on the 2d instant, and were in very fine condition. The ice was not all gone, a chunk remaining that would weigh, I should judge, 10 or 15 pounds. After unpacking we picked out 615 dead eggs, and since then 685, or about 1,300 all told.

[II.—From FRANK N. CLARK, Northville, Mich., March 3, 1882.]

The second lot of California trout eggs came to hand on the 14th of February, and were in excellent shape.

On unpacking we picked out only 272 dead eggs, and since then 384 more, or 656 altogether, which represents almost the entire loss, as they are now hatching very freely.

This was an unexceptionally fine lot of eggs, and they were packed in a superior manner, and appear to have been handled with due care while in transit.

[III.—From E. M. STILLWELL, Bangor, Me., April 25, 1882.]

The trout eggs (10,000) arrived here Sunday morning, April 23, and were sent up to our hatching-house at Enfield yesterday morning, unpacked, and placed in the hatching-troughs. They were in excellent condition, there being but 80 bad eggs in the whole lot.

[IV.—From WILLIAM GRIFFITH, fish commissioner of Kentucky, Louisville, Ky., April 26, 1882.]

In reply to your favor of 13th instant, allow me to say that 5,000 McCloud River trout eggs were received April 13, at 10 a. m.; unpacked at 12 m. One pound of ice on eggs. Eggs in good condition. Number of bad eggs when unpacked, 316.

[V.—From W. E. SISTY, fish commissioner, Idaho Springs, Colo., May 3, 1882.]

I received 10,000 California trout eggs on the 23d of April, and found, upon opening them and placing them in the hatching-troughs, that they were in very good condition. I will be pleased to report to you the success I have in hatching them.

Very few fish have been lost by death this year. Even during the spawning season but a small percentage died. Mr. Myron Green, who has charge of the ponds, says that the trout recuperate very rapidly indeed after spawning, and that many which were weak and thin and apparently past recovery when spawned became in a few weeks as well and handsome as ever.

There are now in the ponds about 2,000 trout, the smallest of which weighs 2 pounds or perhaps 1½ pounds, and the largest not far from 10 pounds. The average size is about 3 pounds, making a total weight in the ponds of 6,000 pounds of trout.

In order to keep the fish safe the ponds have to be watched very carefully. Wild cats, lynxes, coons, otters, and minks are very numerous about the ponds, the wild cats and lynxes being the boldest and most destructive to the fish. Notwithstanding the reputation which the cat has had from time immemorial of being disinclined to wet its feet, the wild cats (*Lynx rufus*) and lynxes (*Lynx canadensis*) here, Mr. Green says, will even jump into the ponds in their eagerness to get the trout. I might add that the panthers (*Felis concolor*) have become recently very bold and very numerous in this vicinity. In September of this last year while I was there a large panther came down three nights in succession close to the house of a settler, who lives across the river from the salmon fishery, and carried away several pigs. One also sprang close behind Mr. Myron Green one evening last spring, when he was going home, and caught his dog. It is estimated that the panthers have killed twenty-five hogs on the other side of the river this year, besides many calves, colts, and even full-grown cattle. They have never yet been known, however, to kill the fish in the trout ponds.

Before closing, allow me to say a few words regarding the question whether there is more than one variety of black-spotted trout in the McCloud River. It is settled definitely that the McCloud River contains *Salmo irideus*, the coarse-scaled trout of the McCloud River proper, which grows to a weight of 8 or 10 pounds, has an obtuse nose and large eyes, with bright red gill-covers and a broad red band along its body. We know that this fish is in the McCloud River, for there are hundreds, thousands, indeed, in the ponds of the United States Fish Commission on the McCloud, which have been caught in the river and placed in these ponds from time to time. The question remains, is there another kind of black-spotted trout in the ponds or in the McCloud River finer scaled and differently shaped? With special reference to this question I took a day to examine the trout in the United States ponds on the McCloud

River. These fish, two or three tons in all, were caught in the river and tributaries, and all, or nearly all, are above 2 pounds in weight, and probably all are over two years old.

After a thorough examination of the fish, both alive and dead, I am compelled to give it as my opinion, which I admit is not based on a scientific study of them, that there is only one variety of black-spotted trout in the United States ponds on the McCloud River, or that if there are two or more varieties, they shade into each other by imperceptible degrees.

It is the opinion of Mr. Myron Green and Mr. Loren Green, who have had more experience with these fish than any other white men, that there is only one variety of trout in the United States trout ponds and in the McCloud river, or, if there are more, that they breed together indefinitely, so that all specific characteristics of distinct varieties, if there were any, have become lost.

One thing is certain, which is that if there are two or more species of trout in the ponds, the eggs distributed from these ponds are the fruit of an intermixture of both or all the varieties, for the males and females in the ponds are used indiscriminately in the spawning season, and all seem to be equally efficient in producing fertilized ova.

The only distinction which the writer could discover between the so-called fine-scaled and the coarse-scaled varieties was simply this, viz: that the larger fish in the river were coarse-scaled and the smaller fish in the brooks which flow into the river were fine-scaled. This holds true universally. It is the general opinion on the river (which opinion the writer shares) that the trout in the river are the same variety as the trout in the brooks, but that the younger and smaller trout affect the brooks, and the larger and older ones prefer the river. According to the generally received nomenclature in the Eastern States, I suppose the brook trout would be called the fine-scaled or mountain trout (*Salmo clarkii*?) and the coarse-scaled or river fish would be called the McCloud River trout, rainbow trout, or *Salmo irideus*. I confess the subject is very much of a puzzle to me still, particularly because persons who have hatched the California trout eggs and have raised the fish from them, are very positive that what are called the California mountain trout and what are called the California McCloud river trout are two distinct varieties; while, according to the theory just presented, they ought to be both the same variety. Mr. Roosevelt speaks very decidedly about it, and says that "the distinctions between the McCloud River and the mountain trout are quite apparent to the eye;" that "there is some difference in their habits"; that the mountain trout does not grow to more than half the size of the McCloud River trout, and that when cooked there is a marked superiority in favor of the mountain variety. This, I believe, is also Seth Green's opinion. Now, if this is all true, and I do not here dispute it, how does it happen that we have only one kind of trout in the ponds of the United States Fish Commis-

sion on the McCloud River? Our trout there have been taken indiscriminately from brook and river, and if there are two distinct varieties in the river and its tributaries, it seems impossible that both varieties should not be represented among the thousands of trout in the ponds, but they are not. Unless appearances are very deceptive, the ponds contain but one variety of trout.

Leaving this subject here for the present, I will merely add in conclusion that a large number of wild breeders have been caught in the river during the last year and placed in the ponds; that all the trout are now in fine condition, and that there is a flattering prospect of taking an excellent lot of eggs during the next spawning season, which promises to come on very soon.

Table showing the number of trout (Salmo irideus) eggs distributed in 1882 from the United States trout-breeding station on the McCloud River, California.

Date.	Destination.	No. of eggs shipped.
Jan. 25	F. N. Clark, Michigan	55,000
Feb. 5	......do	40,000
20	Central hatching-station, Washington, D. C	15,000
Mar. 2	......do	18,000
15	E. G. Blackford, New York	20,000
15	R. O. Sweeney, Michigan	5,000
28	M. F. Bailey, Wisconsin	10,000
28	Seth Weeks, Pennsylvania	10,000
28	Calvin Fletcher, Indiana	5,000
Apr. 5	C. H. Brownell, Missouri	10,000
5	J. G. Portman, Michigan	10,000
5	Peter Walsh, Colorado	5,000
5	Calvin Fletcher, Indiana	5,000
13	E. M. Stillwell, Maine	5,000
13	William Griffith, Kentucky	5,000
13	W. E. Sisty, Colorado	10,000
13	B. F. Shaw, Iowa	10,000
14	E. A. Brackett, Massachusetts	5,000
14	D. B. Long, Kansas	1,000
19	H. J. Fenton, Connecticut	10,000
22	C. H. Barber, Vermont	5,000
24	B. B. Redding, California	5,500
28	E. G. Blackford, New York	10,000
May 4	B. B. Redding, California	10,000
6	......do	5,000
9	N. K. Fairbanks, Illinois	10,000
9	Mrs. Slack, Illinois	10,000
12	C. S. White, Illinois	4,000
12	A. Powers, Illinois	4,000
15	B. B. Reeding, California	10,000
	Eggs hatched and planted in the McCloud River during the season	10,000
	Total	337,500

XXXI.—REPORT ON THE PROPAGATION OF PENOBSCOT SALMON IN 1882-'83.

By Charles G. Atkins.

1. Routine Work.

At this station the arrangements of former years were continued, Mr. Buck remaining in charge, and the salmon being collected at the south end of Verona by Mr. Whitmore and confined in the inclosure in Dead Brook, whither they were taken in submerged cars.

The season's work opened with the purchase of adult salmon June 3, 1882. There were received in all 586 salmon, of which the last were inclosed June 29. The weight of 473 individuals was estimated singly, and their general average was 13.04 pounds, which is about the ordinary size, but 4 pounds under the average of 1881. They did not appear to be up to the ordinary standard in fatness, but no measurement was made to determine this point. It is quite possible that this was a false impression occasioned by a comparison by memory of the fish with those of the preceding year, which were thought to be remarkable for plumpness as well as for length.

With the hope of lessening the mortality occurring during the term of imprisonment, some changes were made in the cars, and fine minnow nets were used for dipping, but no very decided result followed these efforts. The summer mortality in 1881 was 146 out of 509 deposited in the inclosure. This year out of 560 placed in the inclosure 134 were found dead, and this number should possibly be increased by adding 13 more which were missing at the end of the season. The slight improvement shown by these figures may have been owing less to better handling than to the fact that the salmon this season were of smaller size than in 1881, a circumstance that experience has shown to be favorable.

However, at the spawning season, there were found to be on hand 440 healthy salmon, of which 256 were females and 184 males—58 and 42 per cent., respectively. The most of these were weighed and measured, and the results may be stated thus:

Males, 121 measured.

Length:

Average	inches..	32.1
Longest	do....	41.5
Shortest	do....	28

Males, 121 measured—Continued.

Weight:		
Average	pounds..	10.9
Heaviest	do....	22.3
Lightest	do....	7

Females, 246 measured.

Length:		
Average	inches..	31.5
Longest	do....	39.5
Shortest	do....	26
Weight before spawning:		
Average	pounds..	12.2
Heaviest	do....	28.1
Lightest	do..	5.6
Weight after spawning:		
Average	pounds..	9.4
Heaviest	do....	23.8
Lighest	do....	4

The first spawn was taken October 28. The work was nearly completed November 9, but the last eggs were not taken until November 23. Spawn was obtained from 250 females, and the total number of eggs was estimated at 2,090,000. The mean yield was thus 8,360 per fish.

The eggs were kept in the coolest water at command until sufficiently developed for shipment. The losses sustained during the development aggregated 90,000, of which it is estimated that 42,000 were unimpregnated. From these figures we deduce that 98 per cent. of the eggs were impregnated and 95.7 per cent. were shipped.

The eggs available for shipment numbered 2,000,000. Based on the contributions to expenses a pro rata division gave to the United States Commission 1,208,000 eggs; to Connecticut, 132,000; to Maine, 440,000; to Massachusetts, 220,000.

The transfer of the Penobscot eggs is now effected by precisely the same methods employed for years at both the Maine stations, except that the protecting envelope is latterly composed of chopped hay in a somewhat thicker layer than is necessary with moss. The moss is difficult to obtain at Orland, and the hay is found to be a very satisfactory substitute. In all cases, however, wet bog-moss is still the material in which the eggs are first embedded.

As will be seen by reference to Table 1, all the packages reached their destination in safety, and with two exceptions the number of eggs found dead on unpacking was insignificant—less than two per thousand. The exceptions were two lots that were sent to Enfield and Norway, Me., March 1, in which the losses were, respectively, 20 and 14 per thousand (=2 and 1.4 per cent.). The true explanation doubtless is that these

eggs had accidentally escaped the scrutiny by which the unimpregnated were removed in preparation for shipment.

The hatching out and planting also appear to have been attended with a good degree of success and, as the footing of Table II shows, there were 1,716,617 young salmon safely turned out in public waters. The difference between this number and the original 2,000,000 eggs shipped is partly accounted for by the number (75,000) devoted to exhibition and laboratory purposes.

2. Recovery of marked salmon.

In the autumn of 1880, after being manipulated, 274 salmon were marked for future identification; 193 of these were females, 81 were males. The method of marking was similar to that employed at Bucksport in 1873. A tag of very thin platinum, about half an inch long and a quarter of an inch wide, stamped with a number, was attached by fine platinum wire to the rear margin of the main dorsal fin, and a record made of the number, with the sex, length, and weight of the fish. These fish were, at the close of the spawning season, dismissed into the open "Narramissic" or Eastern River. Twelve of them were recovered in 1881, in April and May, all in poor condition. Doubtless many others were taken or killed and not reported. Previous experience had taught us to expect the return of these fish in good condition in 1882, and a reward of $2, in addition to market value, was offered for each salmon bearing a tag. The number brought in was less than had been hoped for, but was perhaps quite all that should be expected when we consider the many chances against a tag remaining in place. For instance, the fine wire is liable to create a sore or to cut its way out through the margin of the fin or of the tag by the inevitable sawing motion created by the swaying of the fish in swimming; or it may be torn off by contact with some foreign object; or possibly the shining bit of platinum may be seized by a neighboring salmon or some other fish. However, from the data afforded by the salmon actually recovered we obtain a substantial corroboration of the conclusions drawn from previous experience. The following statement shows the entire record of each fish recovered:

No.	Sex.	When marked.	Length when marked.	Weight when marked.	When retaken.	Where retaken.	Length.	Weight.	Increase in weight.*
		1880.	*Inches.*	*Pounds.*	1882.		*Inches.*	*Pounds.*	*Per cent.*
1135	Female.	Oct. 28	30	7.5	June 20	No. Bucksport	34.5	16.5	127
1136	Female.	Nov. 1	31	8.25	June —	Searsport	35.5	17.25	112
1239	Female.	Nov. 5	36	14.5	June 22	Sandy Point ..	39.25	21	45
1248	Female.	Nov. 5	32	8	June —	No. Bucksport	39	21	162
1274	Male...	Nov. 12	30	8.5	June 23	Frankfort	....	14.75	79

* See revised estimates below.

It must be borne in mind that when these fish were marked they were in exceedingly poor condition, having just been deprived of their

spawn after a summer's fast. To arrive at a correct estimate of their rate of growth, we should compare their size when retaken with their probable size at the time of their original capture in June, 1880. The record books show the weight of spawn taken from each female. The difference between the average of estimates in June and of ascertained weights in November may be taken to represent the waste of flesh during the period of confinement. This is found to be 10.5 per cent. of the November weights before spawning. Calculating the original weight from these data the following table may be constructed, to exhibit the rate of growth:

No.	Sex.	Weight June, 1880, computed.	Weight November, 1880.		Weight June, 1882, computed.	Increase in two years.			
			Before spawning.	After spawning.		Weight.		Length.	
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Per cent.*	*Inches.*	*Per cent.*
1135	Female	10.43	9.44	7.50	16.50	2.07	19.8	4.5	15
1136	Female	11.53	10.44	8.25	17.25	5.72	49.6	4.5	14.5
1239	Female	19.61	17.75	14.50	21	1.49	7.6	3.25	9
1248	Female	11.39	10.31	8	21	8.61	75.6	7	21.9
1274	Male ...	9.49	8.50	8.50	14.75	5.26	54.4	....	....

Thus the four females made in two years an average increase of 31.9 per cent. in weight, and of 14.2 per cent. in length. Those varying from 10 to 12 pounds on original appearance range from 16.50 to 21 pounds on recapture.

Taken in connection with previous experience at this station, the results obtained from this experiment warrant us in saying that salmon visit the Penobscot River for the purpose of spawning but once in two years, and that they visit it for no other purpose is well established.

TABLE I.—*Statement of the shipment of Penobscot salmon spawn from Orland, Maine, in 1883.*

Date of shipment.	Consignee.	Address.	Final destination.	No. of cases.	Number of eggs. From share of States.	Number of eggs. From share of United States.	Number of eggs. Total.	Distance transported.	Hours en route.*	Condition on unpacking.	Number dead on unpacking.
1883.								*Miles.*			
Jan. 29	H. J. Fenton	Windsor, Conn	Poquonock, Conn	1	50,000		50,000	391	54	"Good"	92
29	George Jelliffe	Westport, Conn	Westport, Conn	1	50,000		50,000	466	57	"Good"	76
29	United States Fish Commission.	Washington, D. C	Washington, D. C	3		220,000	220,000	739	78	"Excellent"	126
31	do	do	do	2		120,000	120,000	739	76	"First class"	160
31	E. G. Blackford	Fulton Market, New York	Cold Spring Harbor, New York.	4		260,000	260,000	537	79	"Excellent"	296
Feb. 5	E. B. Hodge	Plymouth, N. H	Plymouth, N. H	2	160,000		160,000	404	51	"Good, except a few that were frozen."	60
5	United States Fish Commission.	Washington, D. C	Washington, D. C	1		80,000	80,000	739	78	"Excellent"	18
5	E. G. Blackford	Fulton Market, New York.	Cold Spring Harbor, New York.	1		50,000	50,000	537	102	"Excellent"	48
6	E. B. Hodge	Plymouth, N. H.	Plymouth, N. H	1	60,000	20,000	80,000	404	51	"Good"	56
6	George Jelliffe	Westport, Conn	Westport, Conn	1	32,000	18,000	50,000	466	55	"Good"	88
14	O. A. Dennen	Moosehead Lake, Maine	Mount Kineo, Maine	2	100,000		100,000	121	32	"Good"	100
14	D. H. Harmon	Norway, Me	Norway, Me	2	120,000		120,000	210	29	"Good"	91
14	Benjamin Lincoln	Dennysville, Me	Dennysville, Me	1	40,000		40,000	93	73	"Good"	50
14	E. G. Blackford	Fulton Market, New York.	Cold Spring Harbor, New York.	1		40,000	40,000	537	79	"Good"	50
21	H. J. Fenton	Windsor, Conn	Poquonock, Conn	1		60,000	60,000	391	54	"Good"	23
21	George Jelliffe	Westport, Conn	Westport, Conn	1		30,000	30,000	466	52	"Good"	59
21	United States Fish Commission.	Washington, D. C	Washington, D. C	1		80,000	80,000	739	78	"Good"	97
21	Ellis Hanscom	Machias, Me	Machias, Me	1	20,000		20,000	73	104	"Good"	16
Mar. 1	A. J. Darling	Enfield, Me	Enfield, Me	3	105,000	90,000	195,000	60	6	Good	3,900
1	D. H. Harmon	Norway, Me	Norway, Me	1	55,000		55,000	210	30	"Good"	742
5	E. B. Hodge	Plymouth, N. H	Plymouth, N. H	1		65,000	65,000	404	48	"Good"	71
5	Prof. S. F. Baird†	Washington, D. C	Washington, D. C			75,000	75,000	739			
					792,000	1,208,000	2,000,000				

* The figures here given are intended to cover the time between the start from Orland and the unpacking of the eggs at their final destination. The entire time elapsing between packing and unpacking would be from twelve to twenty-four hours longer, as the eggs were generally packed the day before shipment.

† These eggs comprised several series of specimens shipped at sundry times, alive or in alcohol.

TABLE II.—*Statement of the planting of Penobscot salmon fry in* 1883, *reared from eggs collected at Orland in* 1882.

State.	Where hatched.	Waters in which the fry were placed.	Tributary to—	Locality of deposit.	Date of transfer.	Number of fish.
					1883.	
Connecticut	Westport	Housatonic River	Long Island Sound	Cornwall Bridge	Apr. 21	37,000
		Do	do	Kent	Apr. 24	38,000
		Do	do	New Milford	Apr. 30	38,000
		Mill River	do	Southport	May 2	10,000
	Poquonock	Farmington River	Connecticut River			109,419
Maine	Dennysville	Denny's River	Cobscook Bay	Dennysville, Washington County	May 23	20,000
	Enfield	Mattawamkeag River	Penobscot River	Near Bancroft, Aroostook County	June 5	30,000
		Penobscot River	Penobscot Bay	Near Medway, Penobscot County	June 6	30,000
		Piscataquis River	Penobscot River	Dover, Piscataquis County	June 7	30,000
		Mattawamkeag, West Branch	do	Island Falls, Aroostook County	June 8	30,000
		East Branch or Mattagamon River.	do	Near Medway, Penobscot County	June 9	25,000
		Mattawamkeag River	do	Near Bancroft, Aroostook County	June 11	30,000
		Cold Stream and Cold Stream Pond.	do	Enfield, Penobscot County	June 12	20,000
	Machias	Great Brook	Machias River	Northfield, Washington County	May 21	17,448
	Mount Kineo	Socatean River	Moosehead Lake	Tomhegan, Somerset County	June 15	50,000
		Moosehead Lake	Kennebec River	Mount Kineo, Piscataquis County	June 16	30,000
		Hebron Pond	Piscataquis and Penobscot Rivers.	Monson, Piscataquis County	June 29	15,000
	Norway	Crooked River	Presumpscot River	Norway, Oxford County	May 20, 25	170,000
New Hampshire	Plymouth, N. H.*	Pemigewasset River	Merrimack River	Sundry places	June —	299,000
New York	Cold Spring Harbor	Carr's Brook	Hudson River	North Creek, Warren County	May 10	49,800
		Trout ponds of J. D. Jones	South Oyster Bay	Great South Bay, Long Island	May 11	5,000
		Balm of Gilead Brook	Hudson River	North Creek, Warren County	May 15	49,700
		Trout Brook	Salmon River	Albion, Oswego County	May 18	44,200
		Ramont Brook	Hudson River	North Creek, Warren County	May 23	39,000
		Beaver Meadow Brook	do	do	May 24	39,900
		Roaring Brook	do	do	May 25	39,500
		Do	do	do	May 29	27,900
	Washington, D. C	East Branch	Delaware River	Hancock, Delaware County	Apr. 21	112,000
		Do	do	do	Apr. 24	78,750
		West Branch	do	Deposit, Broome County	Apr. 21	112,000
		Do	do	do	Apr. 24	90,000
						1,716,617

* The hatchery at Plymouth is supported jointly by the States of New Hampshire and Massachusetts. In addition to the fry included in above statement were those resulting from 85,000 eggs taken from salmon caught in the Pemigewasset, which fry were deposited in the same river.

XXXII.—REPORT ON THE PROPAGATION OF SCHOODIC SALMON IN 1882-'83.

By Charles G. Atkins.

THE NEW BUILDINGS.

The changes in the buildings rendered necessary by establishment of headquarters at the hatchery at the cove were brought to completion this season, and these matters kept a small force of masons, carpenters, painters, and laborers at work during nearly the whole autumn and winter. We can now congratulate ourselves on being well prepared for the successful management of any stock of eggs we are likely to get, and on a probable suspension of the work of building and tearing down, which has unavoidably attended nearly every season's operations thus far, often to our serious inconvenience during the spawning season. The attendant expenses will likewise doubtless be materially reduced hereafter.

The superintendent's cottage has been moved to a new site, close by the main hatchery, and has received important repairs, extending to finishing and painting within and without.

The group of buildings at headquarters now comprises the main hatchery (No. 3), the superintendent's house, a keeper's lodge, a small ice-house, and a wood-house. Directly in front of the superintendent's house is the fishing ground, with the spawning house and a watch-house perched on a pier in a position commanding views of all the nets. About 50 rods down the stream stands the "river-house," or hatchery No. 2. The original hatchery in the woods completes the list.

2. SPAWNING.

The nets were placed to intercept the descending salmon, as usual, about the middle of September, and on the fourth day of November the arrangements for the capture of fish were completed.

In the early catches the males, as usual, largely predominated, constituting 66 per cent. of those taken November 5; 47 per cent. November 6 and 59 per cent. November 7. The females were in excess November 8 and on every other day to the close of the fishing season, November 20. The totals were 600 males and 1,004 females. In respect to size and condition, they were the finest fish we had ever taken. The males averaged 3.1 pounds in weight and 19.9 inches in length;

the females before spawning 3.2 pounds in weight and 19.3 inches in length. Those females that were ripe when they first came to hand outweighed by an average of one-fifth pound those that were ripe at the first trial, and exceeded them in length by an average of about three-tenths inch. Such differences have been observed before. As compared with the measurements for 1880, both sexes were eight-tenths inch longer this year, and excelled also in weight. As compared with 1876 (the year of smallest averages in our experience), we find this year an increase of 94 per cent. in weight and 28 per cent. in length among the males, while the females have increased 68 per cent. in weight and 22 per cent. in length.

The number of females yielding any eggs that were, on extrusion, white or otherwise evidently defective was smaller than ever before. No record was made of the frequency of the occurrence of this phenomenon until 1881, when 17 per cent. of the female fish were thus defective. This season there were but 7 per cent. The number of eggs affected was in most cases very small, sometimes but two or three from a single fish ; but in rare cases the greater part or the entire litter was affected. No outward symptoms have yet been observed which mark the diseased fish. The phenomenon was quite as common in 1868 as in any recent year.

The exemption of the eggs from visible defects was not, however, attended by a better rate of fecundation than ordinary. The record of losses during the developing period enables me to fix the rate of impregnation at 90.9 per cent., the losses from all causes prior to shipment being 11.8 per cent. In 1881–'82 the percentage impregnated was 92.9 and the losses before shipment 9.2 per cent.—about the ordinary rates.

Of the 1,004 females taken, 945 yielded spawn, of which the total amount weighed 727 pounds 6 ounces, and numbered 1,681,000 eggs. The yield per female fish thus averaged 1,779 eggs, which is the highest average yet recorded at the station.

Details of the spawning operations will be given in Table I, and of the measurements of the fish in Table II.

3. SHIPMENT OF SPAWN

The first shipments were made January 16 and the last March 28.

As usual, the unimpregnated eggs were separated from the others by hand-picking after concussion, and 134,802 were thus removed. This number, added to 63,868 that had previously turned white and been picked out, made a total loss of 198,670, which reduced the stock to 1,482,330 eggs. There were reserved for planting in Grand Lake 374,330, and the remaining 1,108,000 were divided among the subscribers to the fund and shipped to the order of the several commissions interested.

The following schedule shows the amount contributed by each party and their respective shares of eggs:

Contributor.	Contribution.	Share of eggs.
United States	$1,400	478,000
Maine	500	175,000
Massachusetts	500	175,000
Connecticut	500	175,000
New Hampshire	300	105,000
Totals	3,200	1,108,000

Entire success attended the transportation of the eggs, which was performed in the ordinary method and by the accustomed route. A detailed statement of this part of the work will be found in Table III.

4. HATCHING AND PLANTING.

The eggs retained at Grand Lake Stream, 374,330 in number, had been already, in common with those shipped, freed from the presence of unimpregnated individuals, as well as all the imperfect eggs taken out by the pickings previous to the time of shipment. They hatched and came through the yolk-sack period with the trifling additional loss of 568 eggs and 697 fish; and 373,065 young salmon were therefore planted in Grand Lake between June 8 and 22, 1883.

The hatching at other stations was also accomplished with less than the usual loss, in most cases, and a large number of fry planted in various waters as shown in detail in Table IV.

TABLE I.—*Spawning operations at Grand Lake Stream, Maine, in November*, 1882.

Date.	When caught.	Fish at first handling.						Females spawned.		Females with some defective eggs.	Eggs taken.		
		Total, both sexes.	Males.	Females.				First time.	Second time.		Weight.		Number.
				Ripe.	Unripe.	Spent.	Total.				Lbs.	oz.	
1882.													
Nov. 6	Night of November 4-5	148	98	30	20	..	50	30	.....	6			
6	Night of November 5-6	103	48	29	26	..	55	29	.....	2	36	6	90,000
6	Night of November 6-7	168	99	42	27	..	69	42	.....	4	27	9	68,000
8	Respawning	......	....	....	....	..	......	....	72	....	11	13	
8	Night of November 7-8	160	61	48	41	..	89	48	.....	6	41	6	120,000
8	Previously found unripe	......	....	....	....	..	......	22	.....	....			
9	Respawning	......	....	....	....	..	......	....	67	...	8	10	
9	Night of November 8-9	200	74	70	54	2	126	70	.....	7	40	3	116,000
10	Respawning	......	....	....	....	..	......	....	66	...	8	12	
11	Night of November 9-10	147	35	73	39	..	112	73	.....	8	40	12	117,000
11	Respawning	......	....	....	....	..	......	....	71	....	12	0	
11	Night of November 10-11	143	50	64	28	1	93	64	.....	2	33	13	194,000
11	Previously found unripe	......	....	....	....	..	......	54	.....	3	38	6	
13	Respawning	......	...		....	..	......	....	119	....	21	15	
13	Last two nights	220	48	135	32	5	172	135	.....	12	92	2	265,000
14	Respawning	......	....	...		.	......	...	134	....	14	5	
14	Since yesterday	144	25	88	28	3	119	88	....	3	56	8	160,000
15	Respawning	......	....	....	....	..	......	....	95	....	9	11	
15	Night of November 14-15	88	22	47	16	3	66	47	.....	2	31	2	285,000
15	Previously found unripe	......	....	....	....	..	......	133	.....	(*)	84	2	

* Possibly an error of omission.

TABLE I.—*Spawning operations at Grand Lake Stream, Maine, in November*, 1882—Cont'd.

Date.	When caught.	Fish at first handling.						Females spawned.		Females with some defective eggs.	Eggs taken.	
		Total, both sexes.	Males.	Females.				First time.	Second time.		Weight.	Number.
				Ripe.	Unripe.	Spent.	Total.					
1882.											*Lbs. oz.*	
Nov. 16	Previously found unripe	......	....	....	....	..	......	45	.....	2	29 9	97,000
16	Night of November 15–16	38	17	13	4	4	21	13	.....	0	12 5	
17	Respawning	......	....	....	....	..	......	.....	243	....	39 7	133,500
17	Last night	30	11	15	1	3	19	15	.....	0	11 0	
17	Previously found unripe	......	....	....	....	..	......	16	.....	0	9 8	
18	Respawning	......	....	....	....	..	......	.....	31	....	2 10	28,500
18	Last night	9	2	6	1	..	7	6	.....	....	4 10	
18	Previously found unripe	......	....	....	....	..	......	10	.....	....	5 10	
20	Last two nights	6	0	5	1	..	6	5	.....	....	2 14	7,000
	Total	1,604	600	665	268	21	1,004	945	918	57	727 6	1,681,000

TABLE II.—*Measurement of Schoodic salmon at Grand Lake Stream, Maine, November, 1882.*

Date.	Males.							Females gravid (before spawning).							Females measured after spawning.									
	Number weighed and measured.	Weight.			Length.			Number weighed and measured.	Weight.			Length.			Number weighed and measured.	Weight of egg from same.	Weight after spawning.				Length.			Computed original weight of same.
		Average.	Heaviest.	Lightest.	Average.	Longest.	Shortest.		Average.	Heaviest.	Lightest.	Average.	Longest.	Shortest.			Aggregate.	Average.	Heaviest.	Lightest.	Average.	Longest.	Shortest.	
1882.		*Lbs.*	*Lbs.*	*Lbs.*	*In.*	*In.*	*In.*		*Lbs.*	*Lbs.*	*Lbs.*	*In.*	*In.*	*In.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*In.*	*In.*	*In.*	*Lbs.*
Nov. 6	145	3.1	4.5	1.9	19.6	23.5	16.5	42	3.0	4.4	2.2	19.3	21.5	17.0	59	39.8	157.8	2.7	3.9	2.1	19.7	23.0	17.0	3.3
7	96	3.1	4.6	2.0	20.3	23.5	17.5	27	3.1	4.9	2.4	19.4	22.5	17.5	41	27.6	108.6	2.6	3.6	1.9	19.8	21.5	17.5	3.3
8	54	3.2	4.5	2.0	19.7	22.5	17.5	41	3.0	4.4	2.5	19.4	22.0	17.5	48	29.1	136.0	2.8	4.4	2.0	19.7	22.0	17.5	3.4
9	74	3.4	4.9	2.0	20.6	23.0	18.0	54	3.1	4.4	2.3	19.2	21.5	17.5	72	38.6	191.8	2.7	3.8	1.8	19.9	21.0	17.0	3.2
10	35	3.1	4.5	2.3	20.0	23.0	17.5	39	3.1	4.4	1.8	18.9	22.0	16.0	73	40.8	199.8	2.7	4.3	2.1	19.3	22.0	17.0	3.3
11	40	3.1	4.9	2.0	20.3	23.5	17.5	28	3.1	4.4	2.4	19.1	21.0	17.5	54	27.6	141.6	2.6	3.5	1.9	18.9	21.0	17.0	3.1
13	47	3.1	4.4	1.4	20.0	23.3	15.5	31	3.1	4.3	2.5	19.0	21.0	17.5	139	92.1	363.1	2.6	3.8	1.1	19.4	22.0	16.0	3.3
14	25	2.9	4.7	2.1	19.6	23.3	17.5	28	3.3	4.4	2.5	19.2	22.0	17.0	91	56.5	240.3	2.6	4.1	1.7	19.2	22.8	16.0	3.3
15	22	3.0	4.2	1.7	19.6	22.5	16.0	14	3.2	4.3	2.3	19.6	22.0	18.0	50	25.1	133.3	2.7	4.1	1.8	19.3	22.5	17.0	3.2
16	15	2.8	3.8	2.1	19.6	22.0	17.0	4	2.3	2.9	1.3	18.1	19.0	16.0	17	12.5	41.7	2.5	3.1	1.8	19.0	20.5	16.5	3.2
	553	3.1	4.9	1.4	19.9	23.5	15.5	308	3.08	4.9	1.3	19.1	22.5	16.0	644	389.7	1,714.0	2.7	4.4	1.1	19.4	23.0	16.0	3.27

TABLE III.—*Transfer of Schoodic salmon eggs from Grand Lake Stream, Maine, January–March*, 1883.

Date of shipment.		Consignee.	Address.	Final destination.	Number of cases.	Weight.	Number of eggs.			Miles transported.	Hours en route.	Condition on unpacking.	Dead on unpacking.
							Belonging to States.	Belonging to United States.	Total.				
1883.						*Lbs.*							
Jan.	16	E. A. Brackett	Winchester, Mass	Winchester, Mass	1	136	50,000	....	50,000	389	70	"Excellent, could not be better."	20
	16	George Jelliffe	Westport, Conn	Westport, Conn	1	136	50,000	....	50,000	570	80	"First rate"	3
	17	E. A. Brackett	Winchester, Mass	Winchester, Mass	1	164	60,000	....	60,000	389	70	"Excellent; impossible to be better."	23
	17	H. J. Fenton	Windsor, Conn	Poquonock, Conn	1	164	60,000	....	60,000	502	74	"Good; no frost, no indented eggs."	26
	18	Superintend't Druid Hill Fish Hatchery.	Baltimore, Md	Baltimore, Md	1	64½	....	15,000	15,000	805	98	"Good"	3
	18	E. G. Blackford	Fulton Market, New York.	Cold Spring Harbor, N. Y.	1	84	....	25,000	25,000	640	170	"Excellent"	23
	22	E. A. Brackett	Winchester, Mass	Winchester, Mass	1	143	50,000	....	50,000	389	73	"Excellent"	90
	22	E. B. Hodge	Plymouth, N. H	Plymouth, N. H	1	161	60,000	....	60,000	508	142	"Good"	163
	23	E. G. Blackford	Fulton Market, New York.	Cold Spring Harbor, N. Y.	1	201	....	75,000	75,000	640	98	"Good"	231
	23	George Jelliffe	Westport, Conn	Westport, Conn	1	122	37,500	....	37,500	570	80	"Good"	37
	24	H. J. Fenton	Windsor, Conn	Poquonock, Conn	1	120	20,000	20,000	40,000	502	73	"Good"	11
	24	E. A. Brackett	Winchester, Mass	Winchester, Mass	1	90	15,000	10,000	25,000	389	73	"Excellent"	19
	25	S. F. Baird	Washington, D. C	Washington, D. C	1	30½	....	5,000	5,000	848	99	"Very good"	16
	25	Seth Weeks	Corry, Pa	Corry, Pa	1	73	....	20,000	20,000	972	120	"Good; one-fourth of eggs indented."	123
	25	B. F. Shaw	Anamosa, Iowa	Anamosa, Iowa	1	94	....	25,000	25,000	1,607	......	"Good"	....
	25	R. O. Sweeny	Saint Paul, Minn	Saint Paul, Minn	1	103	....	25,000	25,000	1,789	166	"Very good"	132
	29	E. B. Hodge	Plymouth, N. H	Plymouth, N. H	1	181	45,000	20,000	65,000	508	69	"Good"	120
	29	A. R. Fuller	Malone, N. Y	Meacham Lake, New York.	1	30	....	5,000	5,000	583	387	"Good"	51
	29	J. G. Romine	South Bend, Cass County, Nebraska.	South Bend, Cass County, Nebraska.	1	30	....	5,000	5,000	1,925	132	"Good"	19
Feb.	5	O. M. Chase	Detroit, Mich	Cheboygan, Mich	1	87	....	25,000	25,000	1,405	......	"Good"	......
	6	O. A. Dennen	Mount Kineo, Maine	Mount Kineo, Maine	1	214½	73,500	....	73,050	232	146	"Good"	50
	28	Fred. Mather	25 Hill street, Newark, N. J.	Europe	1	161	....	50,000	50,000	645*	93	"Good"	*67
Mar.	6												
	6	O. A. Dennen	Mount Kineo, Maine	Mount Kineo, Maine	1	67	16,500	....	16,500	232	......	Good	......
	6	A. J. Darling	Enfield, Me	Enfield, Me	1	95	25,000	....	25,000	103	44	"Good"	5
	6	E. A. Brackett	Winchester, Mass	Winchester, Mass	1	52	....	10,000	10,000	389	120	"Excellent"	13
	6	H. J. Fenton	Windsor, Conn	Poquonock, Conn	1	43	7,500	....	7,500	502	97	"Good"	13

8	F. N. Clark	Northfield, Mich	Northfield, Mich	1	80	....	20,000	20,000	1,158	98	"Good"	21
19	E. B. Hodge	Plymouth, N. H	Plymouth, N. H	1	28	....	5,000	5,000	508	73	"Good"	4
19	A. J. Darling	Enfield, Me	Enfield, Me	1	148	10,000	39,000	49,000	103	68	"Good"	15
26	H. G. Parker	Carson City, Nev	Carson City, Nev	1	67	....	15,000	15,000	3,560	217	"In first-class shape"	200
27	F. C. Hervey	Rangely, Me	Rangely, Me	1	145	50,000	....	50,000	300	120	"Good"	50
28	....do	......do	......do	1	156	....	50,000	50,000	300	120	Good	......
						630,000	464,000	1,094,000				

* This refers to the transportation to Newark only; of the success that attended them on the passage to Europe I have only the report of those sent to Germany, 25,000, addressed to Herr von Behr, and transported in Mr. Mather's apparatus. They left New York March 10, and arrived at Bremerhaven March 23, were unpacked March 24, and found in "very good" condition, but 103 being dead.

TABLE IV.—*Planting of Schoodic salmon hatched from eggs collected in November*, 1882.

State.	Where hatched.	Waters stocked.	Tributary to—	Locality of deposit.	Date of transfer.	Number of fish.
					1883.	
Connecticut	Poquonock	Snipsic Lake	Hockanum and Connecticut Rivers.	Rockville, Tolland County	From April 24 to June 1.	10,000
		Windsorville Pond	Connecticut River	Windsorville, Hartford County		8,000
		Gardner's Lake	Yantic and Thames Rivers	Salem		8,000
		Preston City Lake	Thames River	Preston, New London County		8,000
		East Lyme Lake		East Lyme		8,000
		East Hampton Lake	Pine Brook and Connecticut River	East Hampton, Middlesex County		8,000
		Hog Pond	Connecticut River	Lyme, New London County		8,000
		Higganum Reservoir	do	Higganum, Middlesex County		8,000
		Ida Lake	do	Portland, Middlesex County		8,000
		Crystal Lake	Willimantic River	Stafford Springs, Tolland County		8,000
		Square Pond	do	Square Pond, Tolland County		8,000
		Mountain Lake		New London		8,000
		Cranberry Pond	Farmington River	North Granby, Hartford County		8,814
	Westport	Goshen Pond	Bantam and Housatonic Rivers	Goshen, Litchfield County	Mar. 26	8,000
		Twin Lakes	Housatonic River	Salisbury, Litchfield County	Mar. 26	8,000
		Lake Wanouscoponous	do	Lakeville, Litchfield County	Mar. 26	8,000
		West Hill Pond	Farmington River	New Hartford, Litchfield County	Apr. 2	8,000
		Ball's Pond	Housatonic River	Danbury, Fairfield County	Apr. 4	8,000
		Waramaug Lake	do	New Preston, Litchfield County	Apr. 6	8,000
		Stream	Quinnebaug River	Norwich, New London County	Apr. 9	8,000
		Mashapaug Lake	Shetucket River	Union, Tolland County	Apr. 11	8,000
		Streams	Housatonic River	New Milford, Litchfield County	Apr. 13	8,000
Iowa	Anamosa	Cedar Lake	Des Moines River	Eldon, Wapello County	Mar. 20	8,000
		Clear Lake	Cedar River	Clear Lake, Cerro Gordo County	Apr. 16	10,000
		Round Lake	Des Moines River	Booneville, Dallas County	June 12	3,000
Maine	Enfield	Cold Stream Pond	Passadumkeag River	Enfield, Penobscot County	June 4	15,000
		Mattaceunk Lake	East Branch Penobscot River	Medway, Penobscot County	June 6	20,000
		Crane's Pond	Penobscot River	South Lincoln, Penobscot County	June 8	20,000
		Cold Stream Pond	do	Enfield, Penobscot County	June 16	10,000
	Grand Lake Stream	Grand Lake	Schoodic River	Hinkley, Washington County	June 8 to 22.	373,065
	Mount Kineo	Socatean River	Moosehead Lake	Tomhegan Township, Somerset County.	June 15	45,000
		Moosehead Lake	Kennebec River	Near Kineo Mountain		30,000
		Hebron Pond	Piscataquis River	Monson, Piscataquis County		15,000
	Rangely	Rangely Lakes and tributaries	Androscoggin River	Franklin and Oxford Counties	July 1–4	98,000
Maryland	Baltimore	Principio Creek		Cecil County		4,000
		Perch Creek		Elton, Cecil County		4,000
		King's Creek		Talbot County		4,000
		Unnamed waters		Garrett County		500
Massachusetts	Winchester					

Michigan	Cheboygan	Teal Lake	Carp River and Lake Superior	Negaunee, Marquette County	June 1	18,000
	Northville	Union Lake		Oakland County	May 28	8,000
		Cooley Lake		do	May 28	2,000
		Union Lake		do	June 13	7,000
		Breeding ponds		Paris	June 14	1,800
Minnesota	Saint Paul	Lake Minnetonka	Mississippi River	Hennepin County	May 14	5,000
		Streams	do	Winona County	June 1	6,000
		Pickwick Lake and Pond	(Landlocked)	Dakota County	June 8	5,000
		White Bear Lake	do	Ramsey and Washington Counties.	June 18	3,000
Nebraska	[All the fry saved, about 1,600, retained for breeding.]					
Nevada	Carson City	Truckee River			June 10	7,000
		Carson River			June 15	7,000
New Hampshire	Plymouth	Squam Lake	Penrigewassett River	Holderness, Grafton County	June 1	10,000
		Long Pond	Connecticut River	Haverhill, Grafton County	June 9	5,000
		Nutt's Pond	Merrimack River	Manchester, Hillsborough County	June 12	5,000
		Massabesic Lake	do	do	June 12	11,500
		Newfound Lake	Penrigewassett River	Bridgwater, Grafton County	June 15	15,000
		Sanbornton Bay	Merrimack River	Laconia, Belknap County	June 16	5,000
		——— Lake	do	Francistown, Hillsborough County	June 16	4,650
		——— Lake	do	Hillsborough, Hillsborough County	June 16	5,000
		Sunapee Lake	Connecticut River	Newbury, Merrimack County	June 18	15,000
		Pleasant Pond	Merrimack River	Pittsfield, Merrimack County	June 23	4,850
		Mink Pond		Lisbon, Grafton County	June 25	5,000
		Bradley Pond	Merrimack River	Andover, Merrimack County	June 25	5,000
		Long Pond	do	Hancock, Hillsborough County	June 29	4,760
		Woodward's Pond	Connecticut River	Roxbury, Cheshire County	July 2	5,000
		Dan Hole Pond	Winnepesaukee Lake	Tuftonborough, Carroll County	June 20	10,000
		Shaw's Pond		New Durham, Strafford County	June 20	5,000
		Tri-echo Lake	Piscataqua River	Milton, Strafford County	June 20	10,000
New York	Cold Spring Harbor	Mill Pond	Long Island Sound	Cold Spring Harbor	May 3	3,500
		Fulton Chain Lakes	Moose River	Near Booneville, Oneida County	May 6	40,000
		Great Pond	Atlantic Ocean	Montauk Point	May 7	5,000
		Bisby and Woodhull Lakes	Black River	Wilmurt, Herkimer County	May 19	20,000
		Mill Pond	Long Island Sound	Cold Spring Harbor	May 25	2,500
		Greenwood Lake	Passaic River	Orange County	June 11	5,000
		South Side Club Ponds	Great South Bay	Oakdale, Suffolk County	June 13	5,000
		Roosevelt's Pond	do	Sayville, Suffolk County	June 13	4,000
	Meacham Lake	Meacham Lake	Saint Regis River	Franklin County	May 1	4,000
Pennsylvania	Corry	Lake Pleasant	Allegheny River	Wattsburg, Erie County	May 28	6,500
		Lake Giles	Delaware River	Millville, Pike County	June 2	12,000

NOTE.—I have been unable to obtain from the Massachusetts Commissioners any statement of the distribution of Schoodic salmon, except that contained in their printed report, which unfortunately does not afford data from which to fill the columns of this table.—C. G. A.

XXXIII.—REPORT UPON THE HATCHING AND DISTRIBUTION OF PENOBSCOT AND LAND-LOCKED OR SCHOODIC SALMON IN THE SPRING OF 1882.

By Fred. Mather.

Concerning the operations of hatching Penobscot salmon and land-locked salmon at Roslyn, N. Y., and distributing them to waters in the State of New York, I have the honor to report as follows:

PENOBSCOT SALMON.

I received your order to try and obtain the use of a hatching house near New York, for the purpose of hatching 120,000 Penobscot salmon eggs, on January 16. I immediately wrote to Mr. Thomas Clapham, Roslyn, N. Y., whom I knew to have one that was not in use. The next day he telegraphed me that I was at liberty to use his house and that he would afford me every facility in his power. I then ordered hatching frames, wire cloth, &c., and on the 20th went to Roslyn and ordered new troughs. The same day, Mr. Blackford telegraphed me of the arrival of the eggs at his place in Fulton Market, New York. Mr. Clapham's hatchery had not been used in some years, and the floor of the building was two feet below ground. He had thrown in earth and made a pond of it. This had to be drained, cleaned, and repaired. On the 28th the frames, troughs, &c., were tarred, and the eggs sent for. They were received in good order (144 dead) and put out. Mr. Atkins telegraphed that 80,000 more were coming, and I had more troughs made and tarred. The second lot arrived at Roslyn February 4, also in good order (37 dead), and the first were hatching freely.

On the 15th of February I learned from Mr. Atkins that 37,500 more eggs were coming, and I telegraphed to Roslyn to have four more troughs made, and the next day went down with the eggs, and tarred the new troughs, and on the 17th 50,000 additional eggs arrived. These last two lots were also in good order (203 dead), but they did not do well after hatching, on account of the insufficient tarring of the troughs, which were of new pine. On the 23d these looked so badly that I determined to double them up in the other troughs and char the ones the fish were in. The fish had a peculiar white liver, presenting a curious spotted appearance as they lay in mass, and there was considerable "dropsy" or blue swelling. In this connection I will take the liberty of calling your attention to extracts from a paper which I read before

the annual meeting of the American Fish-cultural Association April 1, 1882.

I have believed heretofore that every portion of the sac was necessary to the complete development of the fish; and have been rather amused at the innocent question sometimes asked, "When does the sac drop off?" All fish-culturists have noted the fact that an embryo with a small coagulation in its sac, caused by an injury while in the egg, or after hatching, will die near the time that the injured portion is about to be taken up by the absorbent vessels; but, to my surprise, I have seen portions of the sac thrown off this winter, and the fish have lived and taken food afterward.

In this hatchery the troughs were all new, and the haste with which they were made allowed but little time for coating with tar. One trough in particular had but a very light coating, and soon after the hatching of the eggs a singular spotted appearance was observable among the fry. This was caused by the turning white of their livers. Both Professor Ryder and myself examined them under the microscope, and saw the clouded liver, through which the blood appeared to circulate feebly. Knowing no other cause than the exudations of unseasoned pine wood, I removed the fry at once, and placed them in a well-tarred trough, and watched the result. Neither Professor Ryder nor myself thought that the fish, some 15,000 in number, could live. He was of the opinion that the trouble originated in the sac, and that a deficient circulation in some portion had affected the liver. It was a new experience to both of us, and his extensive knowledge of embryology gave his opinion a weight which led me to accept his view, although I could not see any trouble in the sac at this time. I gave him some specimens afterwards which confirmed this theory, which I am now satisfied was a correct one.

The first indication of trouble in the sac was an elongation of the posterior portion of it, and a constriction about midway between its extremity and its connection with the body. Sometimes the portion beyond the constriction contained the large oil globule, and sometimes it did not; and this globule seemed to be very irregular in its position. All the fish in the trough were so affected, and in addition to the "liver complaint," the blue swelling, or "dropsy," appeared. The latter was fatal in every case, the microscope showing a deposit of watery fluid between the two membranes of the sac, in which great numbers of blood corpuscles could be seen drifting about.

In one form, the part cut off from the circulation by the constriction seemed to wither away, and I suspect that only a small portion was affected. In another, a small globe separated from the sac by a cord; and this globe was clear and had no sign of an opaque spot or injury. In a third instance, a larger portion of the sac was cut off by the cord and held suspended, giving somewhat the appearance of the sac and umbilical cord of the skate. Thus far I had but small hopes of the fish surviving, until one day while trying to capture a lively fellow which

had a large ball hanging by a string, the fish made a sudden turn to escape the feather, which was under it, and I saw the cord break and that portion of the sac contained in the ball fall to the bottom. That particular fish was soon lost in the mass and could not be identified. I preserved several specimens which had lost the pendant ball and were about ready to take food. Of the original fifteen thousand in the infected trough, about three thousand died with blue swelling, and two thousand more from other causes, leaving ten thousand fry now taking food, of which a greater portion have lost some part of their sac. I firmly believe that had I not applied a remedy promptly the whole lot would have been past saving if left in that trough twenty-four hours more.

To those to whom it seems incredible that part of the sac of a trout or a salmon should be thrown off by a mighty effort of nature when found to poisoned, I would suggest following my experiment, if a blunder can be so called, and when the liver of the fry turns white, remove the fish into a clean, healthy trough, and note the result.

In this connection it has occurred to me that the reason that trout do not flourish below saw-mills is on account of the water being impregnated with either pine or oak. In 1875 I lost a lot of California salmon at Blacksburgh, Va., in an oaken trough which one of the then fish commissioners of Virginia, in whose employ I was, insisted upon my using. The impregnation of tannin was perceptible to the taste, and the fry died as fast as hatched. The theory of the fishermen near saw-mills is that the sawdust gets into the gills of trout and kills them. This may be true to some extent, but I doubt it, for the reason that sand or other material does not appear to injure the gills, and I have taken adult trout below saw-mills. I incline to think that the mills are destructive merely to the young, by covering the spawning beds to some extent with sawdust, but more by the absorption of turpentine from the pine or tannin from the oak, the evil effects of which we know too well.

From this insufficient tarring I probably lost 30,000 fry more than the regular percentage to be expected, and a lot of 8,000 weak ones, which were crowded against the lower end of a trough, were turned out into Mr. Clapham's stream. By March 6 the white liver had largely disappeared and the dropsical fish had died and no new cases appeared. All went well from this time. The charred troughs were kept for a lot of fish, 57,000, which arrived March 17, making 344,500 eggs in all.

Eggs received.

January 28	120, 000
February 4	80, 000
February 16	37, 500
February 17	50, 000
March 17	57, 000
Total	344, 500

Fry planted.

1882.	
April 13. In Carr's Brook, Warren County, New York	35,000
April 21. Balm of Gilead Brook, Warren County, New York	40,000
April 25. In The Glen, Warren County, New York	50,000
May 4. In Ramont, Warren County, New York	45,000
May 10. In Gulf Brook and Hokum Pond Brook, Warren County, New York	55,000
Total in tributaries of the Hudson	225,000
May 2. In Beaver Dam Brook, Oneida County, New York	25,000
May 2. In Trout Brook, Oneida County, New York	20,000
Total in tributaries of Salmon River	45,000
Planted in Mr. Clapham's brook, Glen Head, N. Y. (sick fish)	8,000
Escaped in Mr. Clapham's brook, Glen Head, N. Y	2,500
Delivered to Mr. Corbin, for stream on South Bay, N. Y	1,000
Total fry	281,500
Eggs left with Mr. Blackford, Fulton Market	8,000
Eggs lost in hatching	4,500
Fry lost in troughs	50,500
Total eggs received	344,500

The loss in eggs and fry was about 14½ per cent., which was largely owing to the limited time in which the troughs were prepared.

The following are the notes taken of the character of the streams in which the fish were placed. The village of North Creek, Warren County, New York, being the northern terminus of the Adirondack Railroad:

Carr's Brook empties into the Hudson on the east side, three miles below North Creek. The fish were placed two miles above its mouth, just above a bridge where two streams come together. A good trout stream with a small dam below. Water 36° on April 14.

Balm of Gilead Brook comes into the Hudson on the west side, four miles above North Creek. A good, swift trout brook with no dams. Fish placed a mile and a quarter from its mouth. Water 35° on April 20.

Glen Brook, near the Glen Station on the Adirondack Railroad, about 15 miles south of North Creek, on west side of Hudson. It is a swift trout stream, with a small dam and saw-mill near its mouth. The fish were planted above the dam about three miles. Water 48° on April 27.

Ramont Brook (I am not sure of the spelling of this name, but give it as the natives spoke it) empties into the Hudson two miles above North

Creek on the west side. A good trout stream, with no mills or dams. Fish were placed a mile and a half above its mouth. Water 40° May 5.

Gulf Brook and Hocum (or Hokum) Pond Brook, both excellent trout streams. The fish were placed at the junction of these two streams, five miles above the mouth, between the villages of North Creek and Weavertown. The stream is on the west side of the Hudson and empties somewhere below North Creek. It has no mills or dams. Water 36° on May 11.

I inclose letters from Mr. Wood on the subject of the deposit in Salmon River. Engagements prevented him from going up and I was met at Albion (Sand Hill post-office) by Mr. V. R. Rich, who knows the streams well. Upon his advice I made the plant in two streams as follows:

Beaver Dam Brook, one mile from railroad station; planted about one hundred rods above its mouth. Put 15,000 below a dam and 10,000 in the pond above.

Trout Brook, or Tuthill Brook, three miles from railroad station, and farther down the river, put in 20,000. It is a good trout stream, and the fish were put in where the road to Richland crosses the stream, just below a mill, on May 2. Temperature not taken.

THE LAND-LOCKED SALMON.

On February 18, 10,000 eggs were received at Roslyn; 290 eggs and fry were lost before planting; a trifle less than 3 per cent. Half the fry were sent to the South Side Sportsmen's Club, of Long Island, May 2, and the remainder I took to Rome the same day, and sent them on alone to Syracuse, while I went to Salmon River with sea salmon. At Syracuse they were met by Mr. James S. Plumb, of that city, who took them to Skaneateles and deposited them in Skaneateles Lake.

On May 18 I packed up the property belonging to the Fish Commission, except the troughs, which are very poor ones, and sent it for storage to Mr. Blackford, Fulton Market, New York.

NEW YORK, *May* 20, 1882.

XXXIV.—REPORT OF OPERATIONS AT CENTRAL STATION, UNITED STATES FISH COMMISSION, DURING 1882.

By Marshall McDonald.

1. ORGANIZATION AND EQUIPMENT.

The Central Station of the United States Fish Commission is located in what is known as the old Armory Building, corner of Sixth and B streets, southwest, Washington, D. C. For some years under authority of Congress, it has been appropriated for the storage of the collections of the United States National Museum, as also of the reserve material and apparatus of the United States Fish Commission.

In the winter of 1881, when the distribution of carp by car and express shipment was substituted for the detached messenger shipments, it was found more economical and convenient, instead of drawing the fish directly from the tanks at the carp ponds for shipment, to bring them up in quantities to the Armory Building, and to arrange for the shipments from this point. For the convenience of this work several large tanks were constructed, each capable of holding for some days 12,000 to 15,000 carp. An abundant flow of fresh water through the tanks was obtained by drawing upon the city supply; and the fish, although very much crowded apparently, were thus kept in good condition for convenience of shipment. Experiments conducted during the previous season at the barge station on the Potomac River had demonstrated the practicability of transporting shad eggs from stations on the Potomac River 20 miles below Washington, and delivering them in good condition to the hatching station at the navy-yard.

During the latter part of this season this system, which is now known as the *dry method of transportation*, was substituted entirely for the method of transporting in buckets of water, which had been previously in use, the results being so entirely satisfactory as to give assurance that by having recourse to this method we would be no longer restricted to the necessity of establishing our hatching stations at points on the river, which, though convenient to the spawn-takers, are remote from the routes of transportation by which the young fish would have to be moved to distant waters.

The concentration of the work of propagation on the Potomac at Washington, in a locality convenient for observation and for shipment of the fry, promised important results to the Commission, both in awak-

ening a public interest in the work and in greatly cheapening the cost of distribution.

In obedience to instructions from the Commissioner, I accordingly submitted a programme for the organization, equipment, and conduct of central station for the work of propagation and distribution. It was determined to equip the station with the new hatching apparatus, based upon experiments conducted by me during the season of 1881. (For description of this, see Bulletin of the United States Fish Commission, Vol. III, p. 183.)

The water being drawn directly from the city supply, the available pressure at our command was sufficient to dispense with any arrangement for pumping, by which we were enabled to simplify greatly the organization and conduct of the work and reduce the cost of it.

The proper working of the automatic hatching jars depending upon the delivery of the water through them under a constant pressure, and the pressure in the city mains varying from hour to hour and day to day, it was necessary to devise some means to secure a constant head independent of the varying pressure. This was accomplished by placing upon the second floor of the Armory Building a tank with a capacity of 400 gallons of water, into which the water from the city mains was delivered directly, and thence distributed by suitable arrangement of pipes to ten tables occupying a section of the ground floor of the building. By automatic arrangements connected with the tank a constant level of water is maintained in it, and a constant pressure through the jars below. The construction of the tank and connecting pipes for supply and distribution is shown in Plate V. The distribution of water to each of the ten tables and the general arrangement of the interior of the hatching station is shown in Plate I. Each table is 15 feet long, 3 feet wide, and 39 inches high, this unusual height being given for convenience in observing and manipulating the jars. In the center of each table and extending nearly the entire length of it is a water-tight trough covered by a grating. The bottom of this trough has a slight inclination from one end to the other, and delivers the water collected from the discharge through the hatching jars into a waste pipe, which empties it all into the sewerage from the building. Each table can conveniently accommodate thirty jars, having each a capacity of 100,000 eggs, giving a total capacity to the station at one time of 30,000,000 eggs, and for the season of upwards of 200,000,000. This capacity can be increased to any extent desired.

In order to arrive definitely at accurate estimates of the number of eggs manipulated, and to determine the percentage of loss during incubation, a scale is employed, each division of which represents 10,000 eggs. By the application of this to the side of the jar, the eggs being allowed to subside to the bottom, the number of eggs contained in each can be read off accurately. An observation of this kind being made when the eggs are first placed in the jar, and a similar observation re-

peated when the hatching begins, gives us the means of arriving accurately at what had been previously very roughly and inaccurately estimated, namely, the percentage of loss during incubation.

The automatic action of the jars is sufficient to separate entirely the dead eggs from the living, so that when the hatching period approaches the fish-culturist in charge has only to deal with a mass of living eggs, the dead eggs being separated from them and carried off through the exit-tube from each jar, or are collected and fed to the fish in the different aquaria.

In order to provide for the collection of the young fry, when hatching begins, the discharge from the jars, instead of passing directly into the waste, is first conducted into aquaria conveniently placed along the center of each hatching table. To prevent overflow of this and loss of fish, a siphon is placed in each of the aquaria, the shorter end being terminated with a large wire cage covered by a bag of muslin, the longer end being immersed in a glass of water. The effect of this, when once a current of water is started, is to render the action of the siphon automatic and self-adjusting. Free exit is thus supplied for the water, and the straining surface of the muslin bag is so large as to prevent any perceptible suction through it, so that we are thus enabled to collect and hold the young fish in the receiving vessels until they have accumulated in quantity and for convenience of shipment. The arrangement of one of the tables for hatching and collecting is shown in detail in Plate IV.

Thus equipped, the Central Station of the United States Fish Commission entered upon the work of propagation.

2. PROPAGATION.

SHAD.—The methods employed in the transportation of eggs from the collecting stations on the river, as well as the apparatus used in hatching them at the station were novel, and a bold innovation upon the methods and apparatus in use up to that time. Though both had promised well in the experimental investigations conducted the previous season, they were now to be subjected to the test of practical application upon a large scale; and I am glad to be able to report that the results of the work done during the season justified our expectations.

The Navy-Yard Station and the Fish Hawk being both available for the work of shad propagation on the Potomac, it was determined to establish three independent stations, each drawing its supply of eggs from an independent section of the river. The Fish Hawk was stationed at Occoquan, and the lower section of the river, from Stump Neck to Stony Point, assigned as its theater of operations. The upper section of the river, extending from Moxley's Point to Washington, was assigned to the Navy-Yard Station, the Lookout being detailed for the collection and transportation of the eggs to the station. The middle section of the river, extending from Chapman's to Ferry Landing, was occupied

by the force of spawn-takers under my direction, one or more being stationed at each of the large fishing shores.

The Herreshoff launch was assigned for service in connection with Central Station, but being liable to detachment at any time, to take the place of the Lookout, in the conduct of the work at the Navy-Yard Station, it could only be relied upon for work of inspection. It was necessary, therefore, to make arrangements for the transportation of the impregnated eggs from the shores to Washington by public carriers. Arrangements were accordingly made with the steam-tug employed in running fish from the shores to Washington to receive and transport the crates of eggs, and to return the empty crates to the shores.

The irregularity of this service often delayed the movement of the eggs, so that in many cases they did not reach the hatching station until from twenty-four to thirty-six hours advanced in incubation.

When convenient the steamer Corcoran was also used as a means of transportation.

To have attempted under such circumstances the movement of the eggs in water would have involved total loss. The dry method of transportation, inaugurated in connection with the work of the previous season, was determined upon, and the men carefully instructed in the details of handling the eggs, with a view to securing the best results. The transportation crate employed in carrying out this method is shown in the figure, page 887. It consists of twenty shallow frames with wire bottoms. These, when stacked, are bound together by straps, so as to form a package convenient for shipping.

The eggs, as delivered to the station, were immediately transferred to the hatching jars, and the total number received ascertained by measure and recorded. The operation of receiving and transferring the eggs is well illustrated in Plate II.

To determine the percentage of unimpregnated and dead eggs on reception, a second measurement was made at the end of twelve hours, the difference between the two measures giving the percentage of dead and unimpregnated eggs; and the second measurement being the basis upon which our estimates of results in hatching are calculated.

Mr. W. F. Page was placed in charge of the hatching at Central Station, being assisted by details from time to time, as the emergencies of the work required.

The total number of eggs received, as shown by the summary of his report for the season, was 6,706,000; the number lost in incubation, 1,313,000; the total number of fish shipped (product of Central Station), 5,393,000; giving an average percentage of loss in incubation for the season of 19.5.

This percentage is higher than heretofore reported with the methods previously in use, and is to be attributed to the fact that in the use of these jars we have been able for the first time to arrive at an accurate estimate of the percentage of loss actually incurred. Such reports here-

tofore have been only crude guesses. That the percentage of loss was not unusual is shown by the fact that the number of fish produced, if counted by the standards previously employed by the Commission, would have been largely in excess of the entire number of eggs brought to the station.

The number of eggs furnished by Chapman's shore was 1,981,000. The yield of this shore the previous year was upwards of 20,000,000. The White House, which the previous season had furnished nearly 7,000,000 eggs, yielded in 1882 but 2,503,000.

The same proportional diminution of the crop occurred at all the shores occupied by our force of spawn-takers. The season was a disastrous one to the fishermen, the catch having fallen off materially from 1881. The falling off both in the number of fish and in the crop of eggs is probably to be attributed to the abnormal low conditions of temperature prevailing in the river during the season. The discussion of the observations of temperature and the relations of this to the run of fish will be found in another part of the Annual Report.

It is a matter of interest to record that nearly two-thirds of the entire number of eggs for the season were taken between the 25th of April and the 10th of May.

COD.—Early in February, 1882, experiments were instituted with a view of determining the possibility of transferring impregnated eggs of the codfish from New York to Washington, and hatching the same in artificially prepared sea-water at Central Station. Experts of the Commission were sent to New York to report to Mr. Eugene G. Blackford, at Fulton Market, who had made all preliminary arrangements for the conduct of the experiments.

In anticipation of the receipt of eggs arrangements were made at Central Station for circulation of salt water. These were briefly as follows:

A supply tank, into which the salt water was pumped by hand, and from which it flowed continuously through hatching apparatus similar to that employed at Wood's Holl in the season of 1881 and specially devised with a view to handling floating eggs. From the hatching apparatus the water passed into a receiving tank below, from which it was pumped again by hand into the supply tank; the limited amount of water used being kept in continuous circulation and as far as possible aerated in its circuit. To maintain the purity of the water a false bottom was placed in the supply tank, and over this a layer of animal charcoal, through which all the water was required to filter.

The salt water employed in the experiment was made from crystallized sea-salt, the amount used being 5 ounces to the gallon, giving a brine of about the density of the water at Wood's Holl.

The first eggs were received on February 16th, being forwarded on wire-bottomed trays covered with damp cloth. These eggs were a total loss. It was evident that the delicate membrane of the cod egg would not stand the shock of this method.

It was then determined to transfer the eggs in salt water in hermetically-sealed vessels; the temperature during transportation being carried down as nearly as possible to the freezing point, as it was expected that this low temperature would either suspend the development or slow down the rate to such an extent that the eggs would come through from New York to the station without asphyxiating. Several lots of eggs were received during the latter part of February, forwarded as indicated above, and a proportion of them in each case were found to be alive and developing. They were transferred to the hatching apparatus as received; but the results of the experiments were not encouraging. They were interesting, however, in the fact that in one case, especially, a small proportion of the eggs received were in good condition and continued to develop until the eleventh day, when the fish were plainly visible in the egg. We were not successful in hatching any, but it is a matter of interest to record that eggs taken, transported, and subjected to conditions during hatching, as above indicated, were carried along to a considerable distance toward hatching. The embryology of the egg was carefully studied by Mr. Ryder, and the results of his experiments, I presume, have been reported.

SALMONIDÆ.—To test the capabilities of the station for handling the eggs of salmonidæ, and the adaptability of the Potomac water for the incubation of these fall and winter spawning species, I was directed by the Commissioner of Fisheries to subject to incubation lots of eggs of all the species bred by the United States Fish Commission. Accordingly, upon requisition made and instructions received, the following lots were forwarded to the station:

Memorandum of eggs received at Central Station, winter season of 1882–'83.

Whitefish.—November 28, 1882, from Northville	1,000,000
Brook Trout.—November 28, 1882, from Northville	50,000
Brook Trout.—February 6, 1883, from Northville	72,000
Lake Trout.—November 28, 1882, from Northville	50,000
Rangeley Trout.—December 15, 1882, from Maine	20,000
California Trout.—February 3, 1883, from Shasta County, California	52,000
California Trout.—February 5, 1883, from Shasta County, California	22,000
Schoodic Salmon.—February 1, 1883, from Maine	5,000
Penobscot Salmon.—February 1, 1883, from Maine	220,000
Penobscot Salmon.—February 3, 1883, from Maine	120,000
Penobscot Salmon.—February 8, 1883, from Maine	80,000

With the exception of the whitefish, from which very fair results were obtained, it would appear that the conditions presented at this station are unfavorable for breeding the Salmonidæ; and we are compelled to abandon the expectation first entertained of using the station for work with these species, unless it be possible to secure well-water

in place of the Potomac water, as there is unquestionably something deleterious in its effect upon the Salmonidæ. Development up to the period of hatching seems to proceed under as favorable conditions here as elsewhere. The mortality after hatching, however, indicates something radically wrong in the conditions to which the fish are subjected. The 500,000 Penobscot salmon eggs received from the Maine Station were in the very best condition, and during incubation the percentage of loss was very small. The fry continued healthy for a considerable period after hatching until about the time of the absorption of the sac, when a heavy mortality set in, which no measures could arrest; so that of the original 500,000 eggs there remained for shipment but 424,000.

A summary of the results of the work with the Salmonidæ is shown in the following tables, prepared by Mr. W. F. Page from the records of the station:

Disposition of Penobscot salmon eggs received from Bucksport, Me.

1883.	Number of eggs received.	Lost before shipment.	Number of fish delivered for shipment.	Time of hatching.	
				Commenced.	Finished.
February 1	220,000	21,531	198,469	Mar. 3	Mar. 16
February 3	120,000	18,604	101,396	Mar. 5	Mar. 19
February 8	80,000	9,674	*70,326	Mar. 7	Mar. 24
February 24	80,000	15,275	64,725	Mar. 9	Mar. 26
March 30	5,000	5,000		Apr. 6	Apr. 7
April 9	5,000	5,000		Apr. 12	Apr. 12
April 20	5,009	5,009		Apr. 24	Apr. 24
Total	515,009	80,093	434,916		

* Of these 10,000 were sent to the London Exhibition.

SHIPMENTS.

April 21—By Mr. Moore, car No. 1, to New York 225,000
April 24—By Mr. Moore, car No. 1, to New York 209,916

NOTE.—February 14, 1883, found one jar of eggs of the second lot, containing 15,000, shut off from fresh water (how long time not known) by reason of the clogging with trash and mud. Removed 4,509 smothered eggs. February 16, found a further resultant of 536 dead eggs. February 17 got 538 and February 19 got 204, making 5,787. It will be noticed that this is more than died in the regular course of hatching, out of the entire lot of 500,000.

Land-Locked Salmon from Grand Lake Stream, Maine, January 29, 1883 5,000
Shipped by Donnelly to Pennsylvania, April 19 1,467

Commenced hatching February 25, 1883. Finished February 28, 1883.

NOTE.—These eggs were shown at the Preliminary Fishery Exhibition at the National Museum, where the water was 6° or 8° higher than that at Central Station. This, undoubtedly, hastened the time of hatching.

Lake Trout from Northville, Mich., November 28, 1883 50,000
Sent to London Exhibition 7,000
Shipped fish 38,600

TIMES OF HATCHING.

Eggs taken.	Commenced hatching.	Finished hatching.
October 15 to 30	January 15, 1883	February 5, 1883
October 20 to 30	January 27, 1883	....
October 25 to 30	January 29, 1883	March 1, 1883

SHIPMENTS.

April 10, 1883, by Messenger Donnelly to Fleming, N. C.	35,000
April 19, 1883, by Messenger Davenport to Asheville, N. C.	3,600
	38,600
Brook Trout from Northville, Mich., November 28, 1882, Lot A.	50,000
Brook Trout from Northville, Mich., February 6, 1883, Lot B.	72,000

Distributed as follows:

LOT A.

April 4, 1883, Mr. Shaw, Benning's, District of Columbia	200
April 7, 1883, Donnelly, Bath County, Virginia	15,000
April 9, 1883, Moore, Woodmount, Md	8,000
	23,200

LOT B.

April 10, 1883, Carswell, Albemarle County, Virginia	1,000
April 10, 1883, Carswell, Wytheville, Va	5,000
April 16, 1883, Donnelly, Wytheville, Va	2,500
April 17, 1883, Davenport, Rock Creek, Maryland	3,000
	11,500

TIME OF HATCHING.

Eggs taken.	Commenced to hatch.	Finished hatching.
Lot A—October 22 to 29, 1882	January 15, 1883	February 15, 1883
October 31 to November 2, 1882	January 18, 1883	February 16, 1883
November 2 to November 6, 1882	January 26, 1883	February 26, 1883
Lot B—November 18 to November 23, 1882	February 9, 1883	March 20, 1883

CALIFORNIA TROUT.

Date.	Received from Baird, California.	Eggs shipped to North Carolina.	Fish shipped.
February 3, 1883	72,000	3,000	3,950
February 20, 1883	36,000	....	5,750
March 22, 1883	14,000	....	6,028
April 4, 1883	24,000	....	500
April 14, 1883	45,000	....	(*)
April 23, 1883	37,000	....	(*)

* Forwarded to Wytheville.

SHIPMENTS OF FISH.

April 16, 1883, by Messenger Donnelly to Wytheville, Va	5,000
April 17, 1883, by Messenger Davenport to Rock Creek, Maryland	2,500
April 19, 1883, by Messenger Donnelly to Pennsylvania	2,000
April 24, 1883, by Messenger Donnelly to Maryland	6,728

Rangeley Trout from C. G. Atkins, December 15, 1882	20,000
Shipped, fish	15,000

Commenced hatching February 16, 1883. Finished March 4, 1883.

SHIPMENTS OF FISH.

April 9, 1883, by Mr. Moore, to Woodmount, Md	5,000
April 10, 1883, by Messenger Carswell, to Wytheville, Va	5,000
April 16, 1883, by Messenger Donnelly, Wytheville, Va	2,500
April 19, 1883, by Messenger Davenport, Asheville, N. C	2,500
	15,000

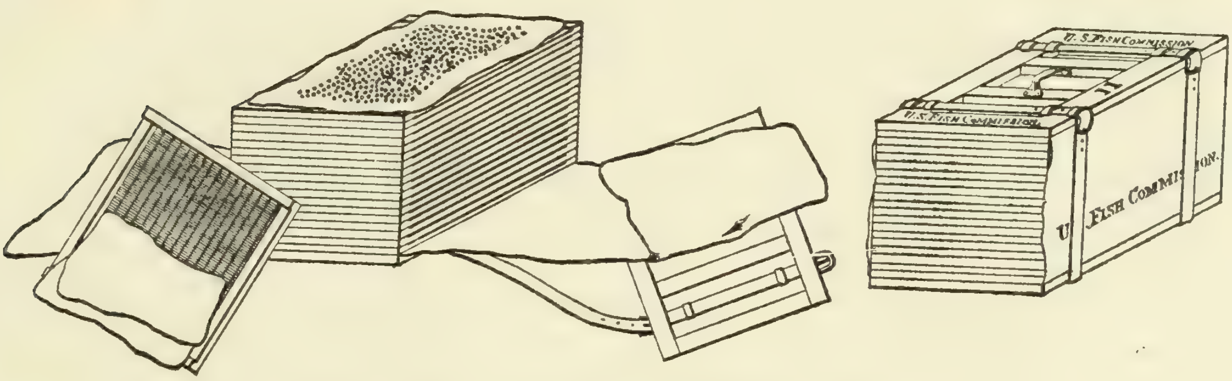


FIG. 1.—Crate for the transportation of shad eggs.

3. DISTRIBUTION.

Under the regulations of the United States Fish Commission the division of distribution is charged with the distribution of all eggs and fish sent out by the Commission, and with all arrangements and correspondence incident and preliminary thereto. The eggs of different species are usually sent from the collecting stations direct to applicants who have made request for the same, or to localities for which they are intended, the assignment, however, being made from Washington by the Commissioner.

The whitefish hatched at our stations in Michigan are sent direct from the stations to the waters for which they are intended, the transporting cars of the Commission being employed for this purpose.

The distribution of carp is made entirely through Central Station, as is also the great bulk of the shad fry, which are hatched for transportation and planting in other waters. The main work of the distribution is done through the instrumentality of the two cars belonging to the Commission, which are specially constructed and thoroughly equipped for this service. Detached messenger shipments are made use of only in cases where the character of the work to be done renders it inexpedient to send out the cars.

In the case of the carp, express shipments are largely resorted to, with the result of introducing great economy in the cost of distribution. Detailed reports of the distribution of carp and shad for the season of 1882 will be found elsewhere in the report.

HERRING.—On the 2d of May 2,000,000 herring were received from the steamer Fish Hawk for distribution. These were forwarded with a shipment of shad to the Colorado River, and deposited at Austin, Tex., May 16. The results of this effort to introduce herring into the Colorado will be looked forwarded to with much interest.

A tabular summary of the whitefish distribution made from our stations at Alpena and Northville, Mich., by car No. 1, is herewith submitted:

Distribution of whitefish eggs and fry in the United States and foreign countries, season of 1882–'83.

Date.	Place of deposit.	No. of fish.	No. of eggs.	To whom shipped.
1882.				
Nov. 26			[1]1,000,000	Central station.
Dec. 18	Minnesota waters	[1]200,000		R. O. Sweeny, Minn.[4]
Dec. 22	Maryland waters	[1]150,000		Thomas Hughlett, Md.[4]
Dec. 24			[1]250,000	S. G. Worth, N. C.[4]
Dec. 27			[1]10,000	G. Ebrecht, Germany.[5]
Dec. 27			[1]200,000	Société d'Acclimation.[5]
Dec. 27			[1]500,000	Von Behr, Germany.[5]
Dec. 28			[1]1,000,000	R. O. Sweeny, Minn.[4]
Dec. 30			[1]1,000,000	R. O. Sweeny, Minn.[4]
1883.				
Jan. 1			[1]250,000	S. R. Throckmorton, Cal.[4]
Jan. 3	New Hampshire waters	[1]200,000		A. H. Powers, N. H.[4]
Jan. 6			[1]500,000	Von Behr, Germany.[5]
Jan. 8			[1]1,000,000	R. O. Sweeny, Minn.[4]
Jan. 9			[1]250,000	S. R. Throckmorton, Cal.[4]
Jan. 11			[1]1,000,000	R. O. Sweeny, Minn.[4]
Jan. 12			[1]1,000,000	R. O. Sweeny, Minn.[4]
Jan. 20			[1]2,000,000	Seth Weeks, Corry, Pa.[4]
Feb. 12			[1]1,000,000	E. G. Blackford, N. Y.[4]
Feb. 22			[1]1,000,000	Charles G. Atkins, Me.[4]
Mar. 20	Nebraska waters	[2]400,000		B. E. B. Kennedy, Nebr.[4]*
Apr. 23	Lake Huron, Sulphur, Mich	[3]2,000,000		H. H. Buck, Orleans, Me.
Apr. 26	Eagle Lake	700,000		
Apr. 26	Lake Michigan, Grand Haven, Mich	[3]2,000,000		
Apr. 28	Lake Huron, Alcona, Mich	[3]3,000,000		
Apr. 29	Lake Huron, North Point, Mich	[3]2,000,000		
Apr. 28	Lake Michigan, Ludington, Mich	[3]2,000,000		
May 2	Lake Michigan, Petoskey, Mich	[3]2,000,000		
May 2	Lake Huron, Black River, Mich	[3]2,000,000		
May 5	Lake Michigan, Kenosha, Wis	[3]2,000,000		
May 5	Lake Michigan, Milwaukee, Wis	[3]1,000,000		
May 7	Lake Huron, Oscoda, Mich	[3]2,000,000		
May 10	Lake Superior, Marquette, Mich	[3]2,000,000		
May 12	Long Lake, Long Lake, Mich	[3]100,000		
May 15	Lake Superior, L'Anse, Mich	[3]2,000,000		
May 16	Lake Huron, Partridge Point, Mich	[3]2,000,000		
May 19	Lake at Michigamme, Mich	[3]1,000,000		
May 22	Lake Michigan, Milwaukee, Wis	[3]1,000,000		
1883.	Lake Ontario, Oswego, N. Y	[3]3,000,000		
1883.	Lake Ontario, Charlotte, N. Y	[1]3,000,000		
1883.	Lake Ontario, Oswego, N. Y	[1]3,000,000		
1883.	Lake Erie, Cleveland, Ohio	[1]2,000,000		
1883.	Lake Erie, Put in Bay, N. Y	[1]2,000,000		
1883.	Lake Erie, Put in Bay, N. Y	[1]2,000,000		
	Total	45,750,000	11,960,000	

* March 26, 1883. By Geo. H. H. Moore, charge car No. 1.
[1] Obtained from Northville, Mich.
[2] Obtained from Central station.
[3] Obtained from Alpena, Mich.
[4] Representing his State Commission.
[5] Through Fred Mather, New York City.

A review of the work done by the two cars during the season of 1882 gives the following interesting summary: The total number of miles traversed by car No. 1 in making the distribution of carp, shad, whitefish, and trout was 31,993, and by car No. 2, 25,354. The average cost per day per man for subsistence was, for car No. 1, $72\frac{43}{100}$ cents, and for car No. 2, $86\frac{1}{2}$ cents.

The number of carp distributed by car service was 220,609; the number of white fish, 34,000,000; shad, 9,300,000; salmonidæ, 472,000.

4. EMBRYOLOGICAL AND EXPERIMENTAL INVESTIGATIONS.

A.—Professor Ryder's Investigations.

In connection with the work of shad propagation at Central Station, and during the progress of it, a series of interesting embryological studies were made by Professor Ryder. These embraced:

I.—Observations on the mode of absorption of the yelk of the embryo shad.

II.—Notice of an extraordinary hybrid between the shad and striped bass.

III.—Cause of the non-development of fungus on the eggs hatched in the McDonald jar.

IV.—Experiments with carbolic acid to kill the fungus on large fishes.

V.—Disturbance of the balance of conditions, and its influence on the crustacean food of the shad.

VI.—A means of demonstrating cartilage in fish embryos.

VII.—Methods of handling white perch ova.

VIII.—Notes on small fishes and water animals which prey on fish larvæ.

IX.—Observations on the food of the young Japanese gold-fishes.

X.—Experiments in supplying the proper food for larval shad.

XI.—Mechanical conditions affecting the development of fish ova.

XII.—Specific character of protoplasm.

A full account of these will be found in Bulletin of the United States Fish Commission, Vol. I, p. 179.

B.—Other Investigations.

A number of experiments were instituted under my direction by Mr. W. F. Page upon the eggs and fry of the shad with a view of determining the influence of different conditions upon the development of the eggs and the health of the fry. The results of these experiments as reported by Mr. Page are herewith appended.

No. 1. May 15. Held 25,000 young shad in asphalt can for seventeen hours without change of water. Afterwards shipped and deposited in good order. Temperature of water at station 53° F.

No. 2. May 16. Hatched 20,000 shad eggs over the oil stove (dark, cloudy day), using a water bath to diffuse the heat. All hatched in twelve minutes. Eggs were well developed, being in about twenty-four hours of their time of hatching naturally. Fish were strong and healthy, and were shipped on the following day by Mr. Newton Simmons to Kentucky, who reported they traveled excellently well with no loss. Temperature of water at station 53° F.

No. 3. May 20—9 a. m. Put 20,000 shad in a wood-bound can. Changed every three hours at 8 p. m.; delivered to Baltimore and Ohio Express Company, for shipment to Mr. Eugene Blackford, of Fulton Market, New York City. Also 4,000 in a small half-gallon pail, under same treatment, shipped at same time. A telegram from Mr. Blackford on the following day announced that in the wood-bound can the fish

were in good condition—only 5 per cent. dead. In small pail 25 per cent. were dead. Temperature of water in pail 54° F.

No. 4. June 4—10 a. m. Put 100 young shad in a pint and half of water. Water stood six inches in height in jar and had surface exposure of 3 inches in diameter. Placed in bottom of jar 24 scraps of sheet zinc $\frac{1}{4}$ inch by $\frac{5}{8}$ inch long. All the fish were dead in thirty hours. The jar was exposed to diffused daylight, and was uncorked. Chemical analysis showed no trace of zinc in solution. Temperature of water at station 70° F.

No. 5. June 4—10 a. m. Put 100 shad under the same conditions precisely as in experiment No. 4, except no zinc or other metal was present. In this experiment all were alive when all were dead in No 4. June 7—10 a. m. Only 25 fish were dead. June 13—10 a. m. Fish have been dying very gradually for past several days. Removed none of the dead, allowing them to drop to the bottom. June 14—10 a. m. All dead. Temperature water used in station varying from 70° F. to 73° F.

No. 6. June 4—10 a. m. Put 100 shad under same conditions as in No. 5, except jar was wrapped and capped with ordinary writing paper stained with writing ink. Fish behaved just as in No. 5, and lived about as long. Could detect no difference.

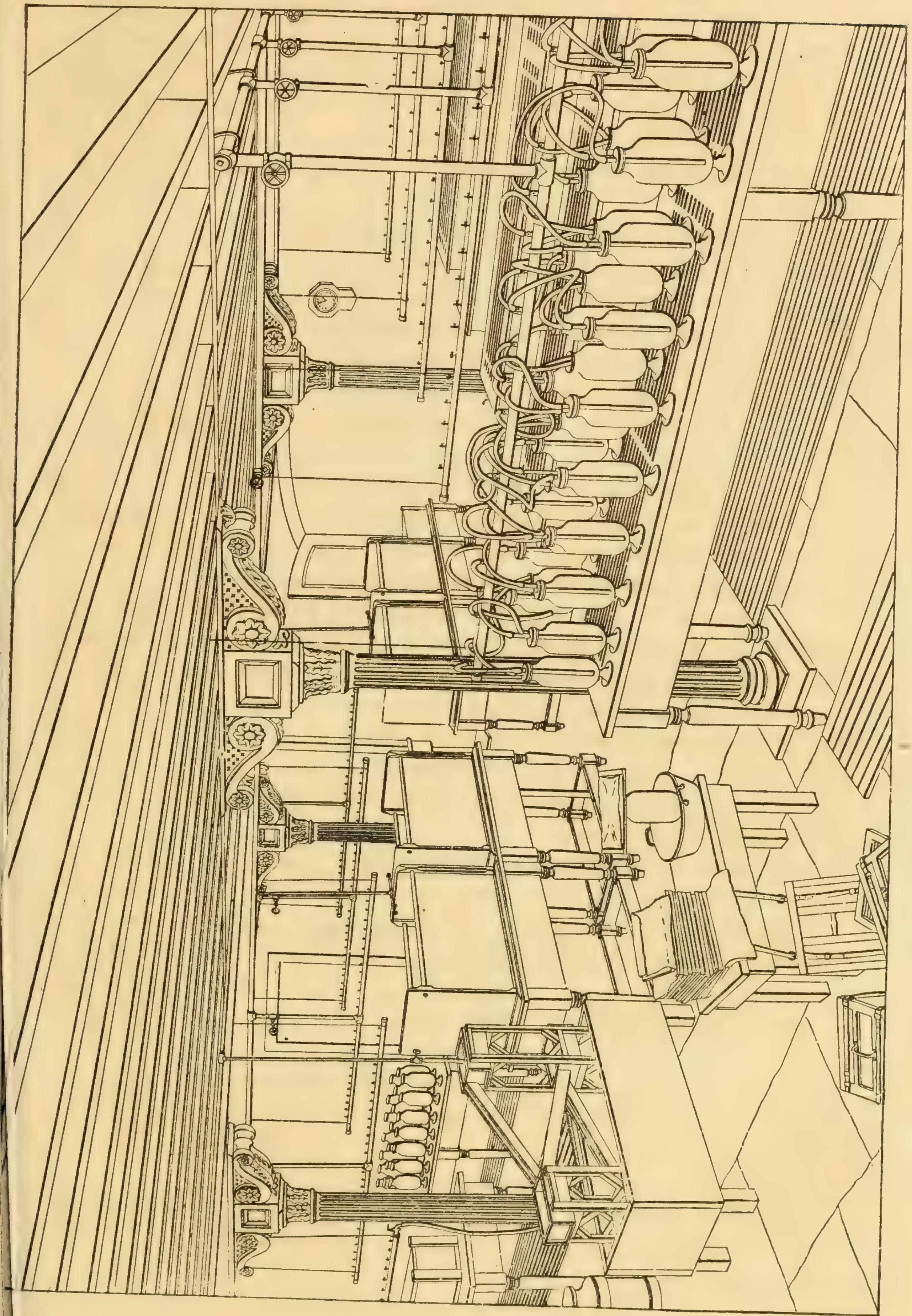
No. 7. June 4, 10 a m. Put 100 shad under same conditions as in experiment No. 5, except placed jar in total darkness as near as could be obtained and permit presence of outside air. June 7, 10 a. m. About 30 per cent. dead. The remaining fish became most violently agitated upon being exposed to the sunlight, some even jumping entirely out of the water. June 13, 10 a. m. Fish have been gradually dying since 7th; only 10 are now alive, and these weak, but agitated still by the light. June 14. All dead.

No. 8. June 7. Spawn-takers at Chapman's shore took 22,000 eggs at 10 p. m. on 7th; put them on trays at midnight; reached hatchway at 1 p. m., June 8, and were put in a McDonald jar which had been heavily coated with asphalt, leaving only a very small unpainted slot to observe the working of the eggs. This slot was turned from the direct light and covered with a flap of black paper when not opened to examine the eggs.

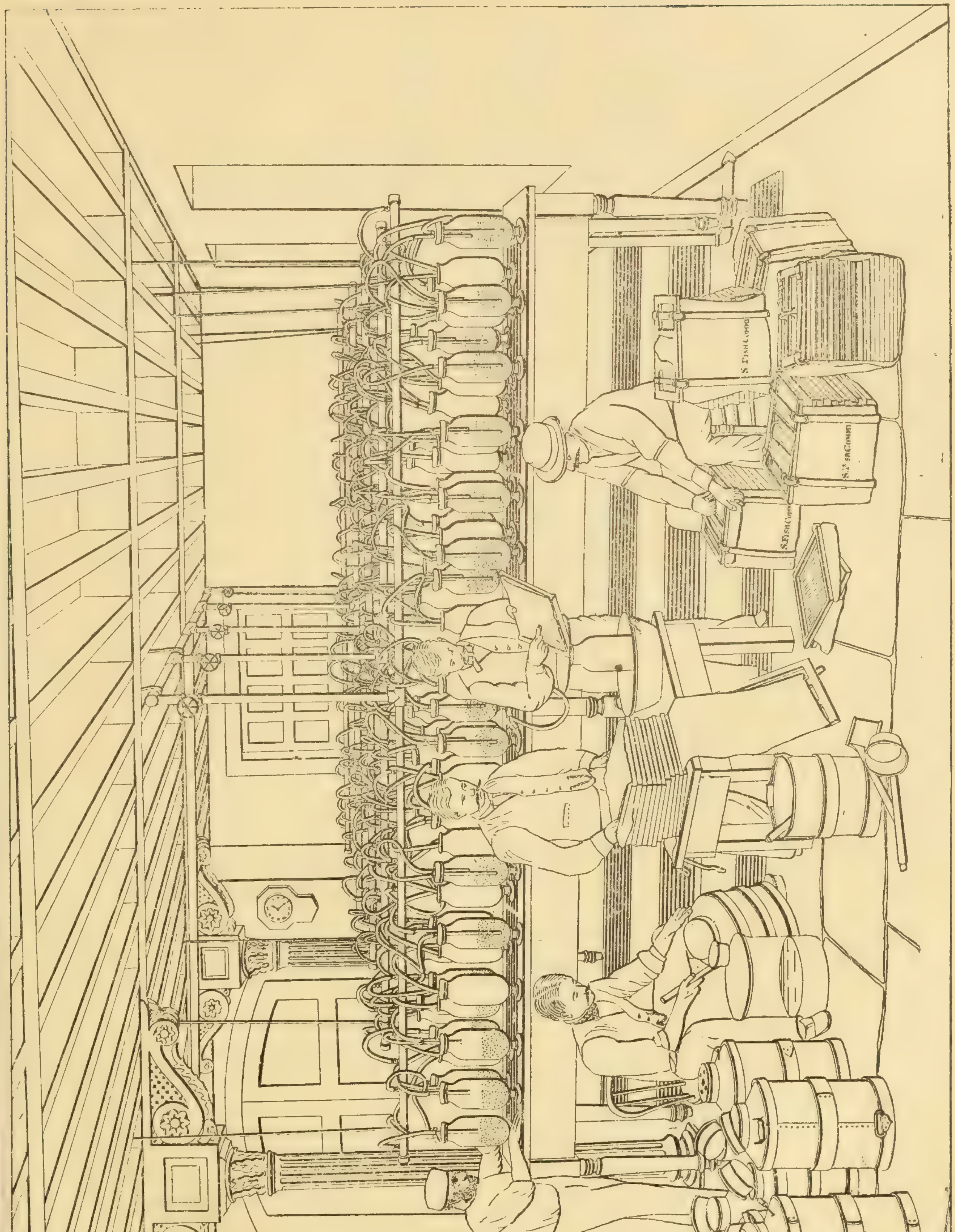
On June 12, a. m., the eggs finished hatching, producing fair percentage of fish. Fish were perfectly normal in size and development of pigments. They were afterwards placed in a separate aquarium and fed on live insects. July 12. Some are yet alive and growing.

No 9. June 8. Placed 100 shad under same conditions as in No. 4, except zinc had been previously coated with asphalt and dried for thirty hours. June 10, 5 a. m. All dead.

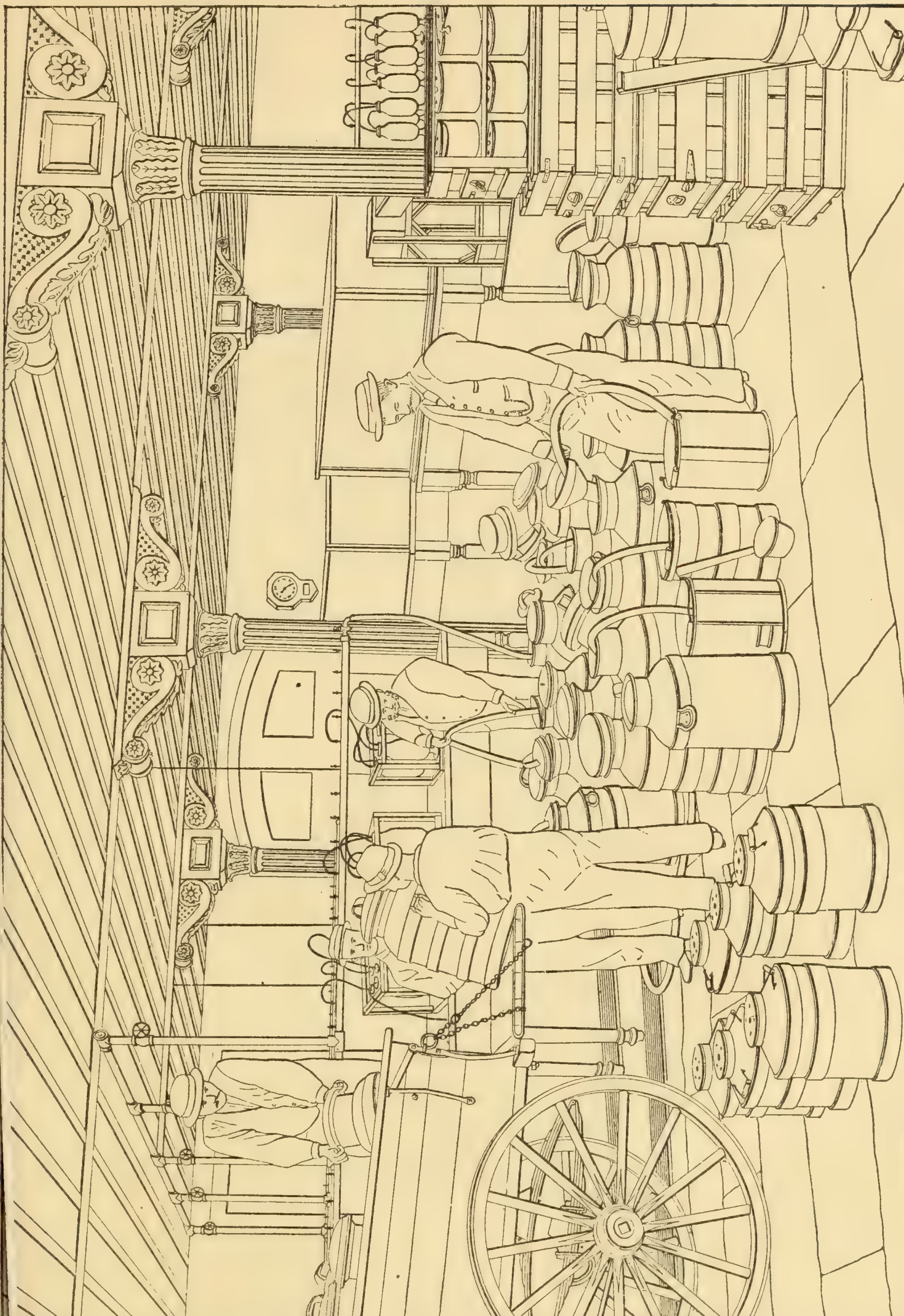
No. 10. June 8, 3.45 p. m. Same as experiment No. 5, except jar was yesterday morning coated inside with asphalt. June 9, 10 a. m. All the fish dead and jar very odoriferous of asphalt.



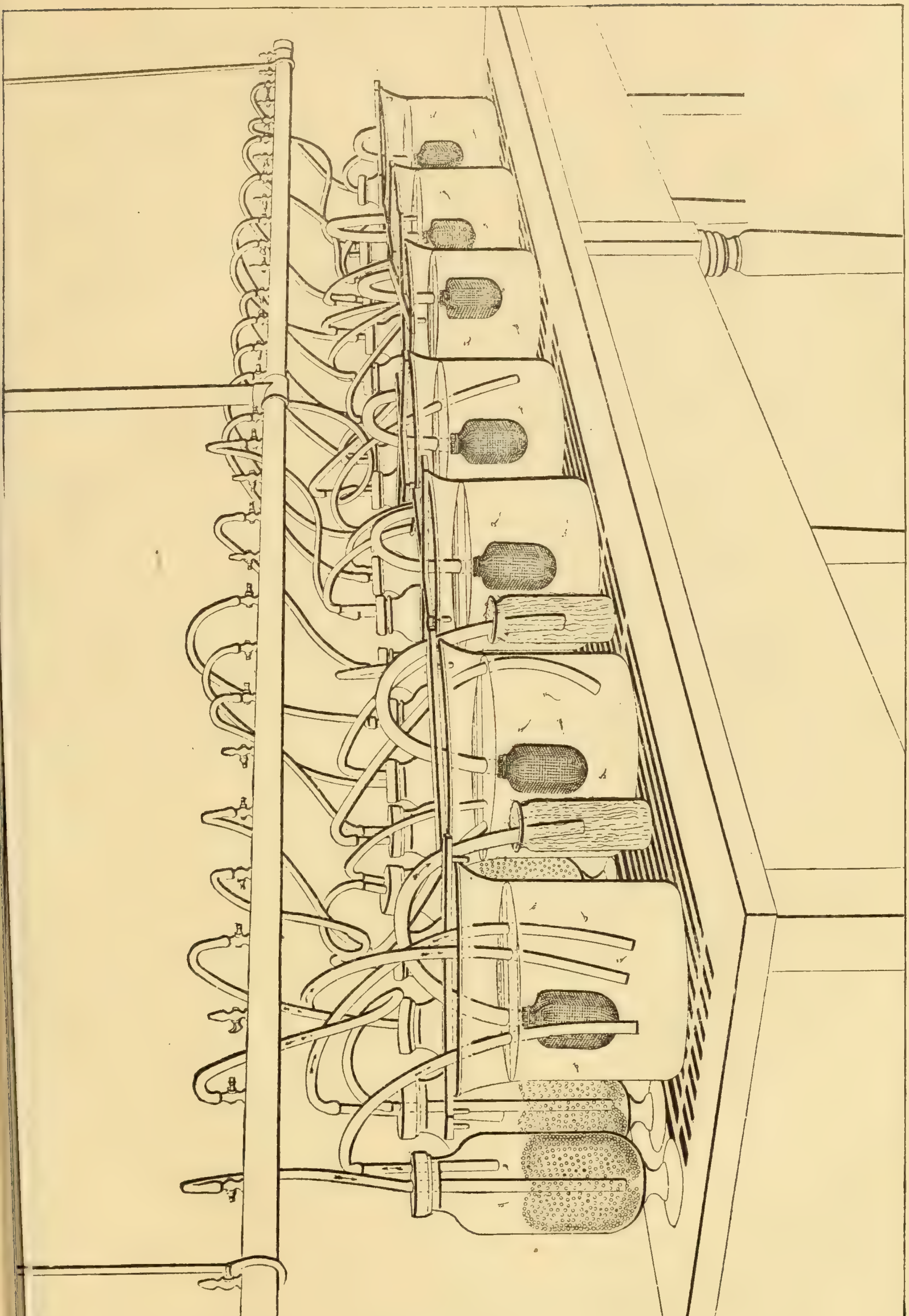
General view of interior of Central Hatching Station.



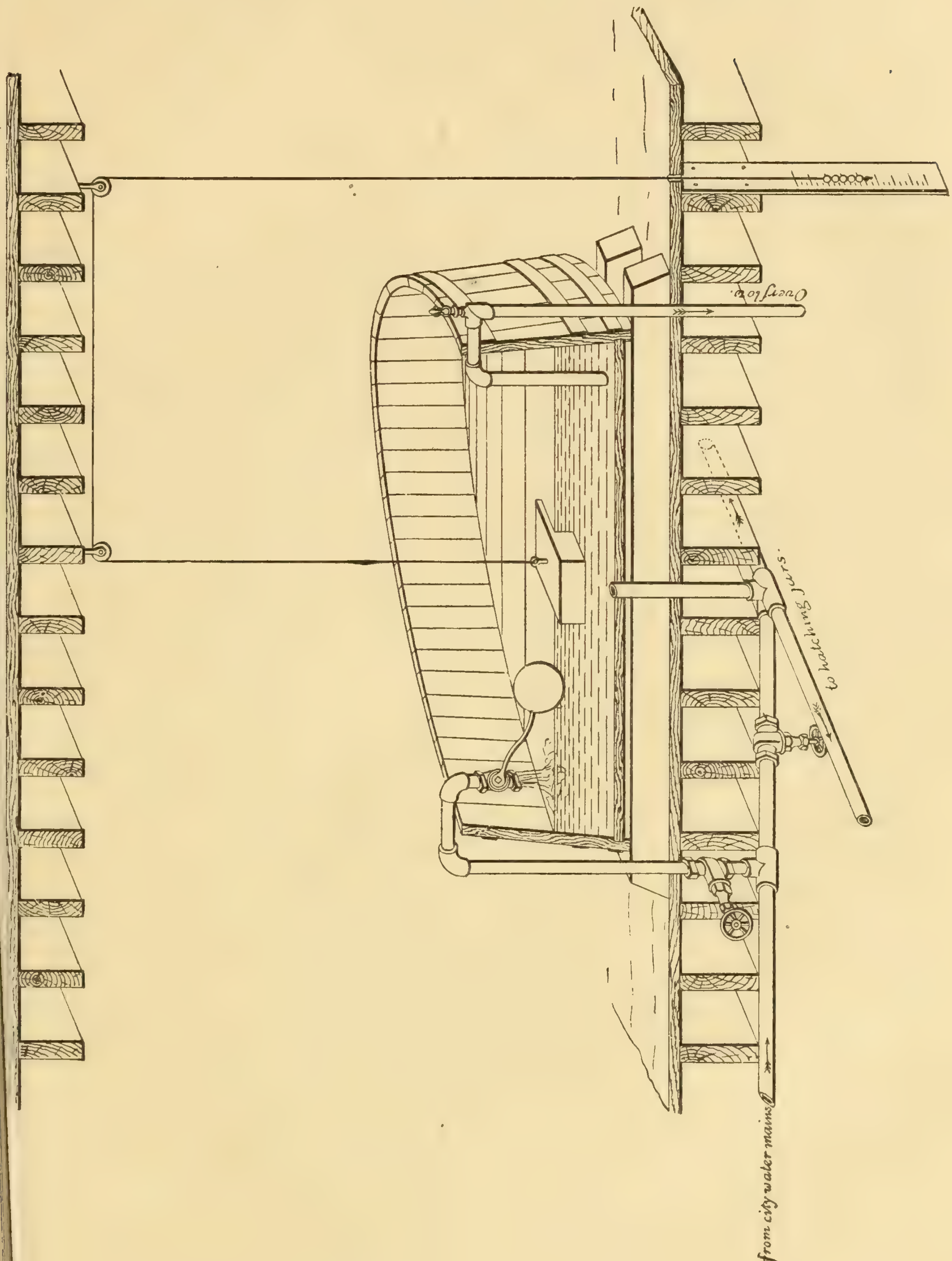
Canning of shad fry for transportation. Receiving the eggs and transferring to the hatching jars.



Making a shipment of shad fry.



Arrangement of hatching jars and aquaria for collecting fry of shad and whitefish as hatched.



Supply tank for regulating the head of water for the hatching jars under varying pressure in the water mains.

XXXV.—REPORT OF OPERATIONS AT THE NAVY-YARD SHAD HATCHING STATION IN WASHINGTON, D. C., DURING THE SEASON OF 1882.

By Lieut. W. M. Wood, U. S. N.

I have the honor to make the following report of the shad-hatching operations carried on at this station:

The station is at the navy-yard, Washington, in the east wing of the boat-house, which forms a large room, having in the center an opening to the water large enough to hoist a boat. The apparatus used was the Ferguson cones. These were forty-eight in number, arranged in eight parallel rows on each side of the open space in the center. The pressure of water was supplied from the city mains, the discharge emptying into the river. The room was lighted by four double windows on the east side and one on the north side. As the season advanced it was found that the cones on the western or dark side yielded nearly 50 per cent. less than those on the eastern side. The eggs in these cones formed in clotted masses that soon emitted a noxious odor, and quickly killed any young fish that hatched. On the 24th of May two large windows were cut on the southern side of the room, admitting much more light and sun. The effect of this was soon appreciable, the western side yielding as good results as the other. Thirteen of the cones on the western side were provided with a new goose-neck, in which the small jet pipe used in the others was omitted. These cones continued to yield bad results, even after the windows were cut, although in some cases the wire-gauze top of the goose-neck was removed.

The steamer Lookout and a Herreshoff steam-launch were attached to the station, making daily trips to the fishing grounds for eggs. The first shad eggs, 40,000 in number, were taken on the 19th of April, and the first shipment of young fish was made the 3d of May to the Sandusky River, Ohio. The weather until May 17 was cold, damp, and rainy, the temperature of the water not being higher than 60° F. at any time, which has been deemed exceedingly unfavorable. The fish hatched took a period of nearly ten days, and seemed quite weak. As the water grew warmer this period gradually decreased. On the 20th of May to eight days, temperature of water 63°; on the 1st of June to six days, temperature of water 69°; and on the 7th of June to four days, temperature of water 70° and 71°.

Although the fishing season began quite early, the cold and rainy weather, with an unusual rise of the river on several occasions, at one

time 6½ feet, soon disheartened the seine fisherman, who began to "cut out." On the 25th of May the seine at Bryant's Point "cut out," and on June 1 the seine at Moxley's Point also "cut out," leaving the gill-net fisherman as the only means of obtaining spawn.

The greatest number of spawning fish taken at one time was at Moxley's Point, May 10, when 31 females and 30 males were taken in a haul of 250 shad. The greatest number of eggs taken in one day was on April 27, when 1,590,000 shad eggs were obtained. Unfortunately, 600,000 of this number were lost by being put into a new tin vessel, which may have contained some small portion of muriatic acid in the solder, although it had been carefully scrubbed. Putting a large number of newly impregnated eggs into a single vessel seems questionable, and may in some measure account for the loss.

A leather carp, weighing from 3½ to 4 pounds, was taken in the seine off Moxley's Point, and on June 1 a female shad weighing 1½ pounds, 13 inches long, and about two years old, was taken, and yielded spawn quite freely. This fish was sent to the National Museum for preservation.

The seine fisheries visited were situated on the eastern bank of the Potomac as far down as Marshall Hall. Most of the eggs were taken at Moxley's Point, owned by Mr. J. H. Skidmore, of Washington. The shoal water there seemed to be the favorite resort of spawning fish. Seventy per cent. of the entire number of eggs were taken here, the seine at Bryant's Point and the gillers off Fort Washington supplying the remainder.

The haul-seine at Moxley's Point, owned by Mr. J. H. Skidmore, is 300 fathoms in length, 25 feet in depth; size of meshes 1 inch to 1½ inches. Total cost of net and roping, \$735; seine, boat, and outfit, \$360; two capstans, \$50 each; making total cost of equipment about \$1,200. Twenty-five men were employed here at \$25 per month each and their board, which cost about 20 cents per day. In addition to these, four foremen were employed, at sums varying from \$100 to \$200 apiece for a season of seven or eight weeks. Getting the fish to market costs about \$7 a day. In addition to the above, three horses were employed to haul the seine. Four hauls were made on each ebb-tide, the flood haul being omitted, owing to the fact Mr. Skidmore did not own the ground below the haul.

The fishery at Sandy Bar, where a good many of the eggs were taken last season, "cut out" after ten days' fishing.

There are twenty-six gill-net fishing-boats between the Eastern Branch and Marshall Hall, two men in each boat; the gill-nets being from 100 to 250 fathoms in length, 24 feet in depth; size of meshes, 5¼ inches; the cost of a 100-fathom net is \$35; boat and outfit \$100; the total cost of outfit being \$135. The men employed receive \$1 per day; the boats and nets being the property of the men fishing them.

There were fifteen pound nets visited, costing \$150 each, the expense

of each net being $60 a month. They require three men and a boat to tend each net, needing great attention, as any sudden rise in the river may wash them away, unless they are hauled up clear of the water. Pound nets this season caught an unusually small number of fish, especially shad, which fishermen ascribe to the prevailing muddy water and freshets.

Several attempts have been made to hatch herring at this station, but with unfavorable results. When the spawn was taken the temperature of the water was so low as to retard their development. On one occasion 3,000,000 herring eggs were obtained, the cold water killing the young fish as soon as hatched.

The jar invented by Col. Marshall McDonald has been used with success on several occasions, the period of hatching being the same as the cones. The eggs taken after the 1st of June turned out badly, a large number of females being found, but no males, so that it was impossible to impregnate the eggs.

The fishing season this year has been unfavorable, owing to the causes previously mentioned, a low temperature of the water and successive freshets.

From the market reports of Washington the following information has been gathered in regard to the total catch of shad and herring in the Potomac for 1881 and 1882, to the 1st of June inclusive:

Months.	Shad.		Herring.	
	1881.	1882.	1881.	1882.
February	40	18	1,000	793
March	5,432	11,639	117,173	40,709
April	237,469	233,444	2,710,496	3,074,162
May	196,928	97,094	5,633,014	3,108,673
Total	439,869	342,195	8,461,683	6,224,337

The following is a recapitulation of the work done from April 19 to June 8, 1882, on which day the station was closed:

Total number of shad eggs received	21,820,000
Total number of shad fry hatched	17,935,000
The per cent. being	82.19

There have been 3,050,000 shad fry put into the Eastern Branch of the Potomac at this station; 1,710,000 into the Potomac at Little Falls; the remainder, 13,175,000, being sent to the Central Station for distribution.

Accompanying the report is the daily journal kept at the station: A form containing the meteorological observations taken three times daily; a form containing the record kept by the spawn-takers stationed at Moxley's Point.

The apparatus designed by me to operate hatching cylinders by means of any small stream of water with slight fall was developed and put in

operation at this station with very promising results. The water used as a motive power was the waste from the cones, and consequently clear gain. The annexed sketch (Plate I) will give a good idea of the apparatus as used here.

A float, A, was built just the size of the slip in the boat-house, the T-ends acting as guides as it rose and fell with the tide. Uprights were erected at each end and in the middle; between these, resting in suitable bearings, were placed the shafts B of 2½-inch iron pipe. Into these main shafts were screwed short pieces of pipe, C, as arms to carry the hatching cylinders. Directly opposite but near the outer end a similar arm, D, was placed to carry the trip-bucket E. This arm has also a movable weight, F, which is used to counterbalance a greater or less number of cylinders by moving it either direction. The waste water was carried over the trip-buckets by suitable pipes.

The operation of the apparatus was as follows: The bucket gradually filling the increasing weight caused it slowly to descend, the cylinders on the opposite side being correspondingly raised. When the bucket filled to the projecting spout shown in sketch, the balance being destroyed it pitched to the front, and, emptying itself, immediately returned by means of a counterbalanced bottom, to the vertical position again. The effect of this sudden emptying destroyed the balance between the rising cylinders on the one hand and the counterbalanced arm on the other, the cylinders plunging back to the position they first occupied. This of course repeats itself indefinitely. The rise and fall each way was regulated by a small guy line. The movement of the cylinders keeps the eggs constantly in motion and gives excellent results.

For hatching floating eggs, such as those of the Spanish mackerel, I would suggest that sufficient agitation and change of water might be had by simply moving the float where it would be acted upon by the waves. This float is very buoyant, as it is composed largely of casks, and dances about at the slightest provocation.

In conclusion, I beg to say that I have been ably assisted in the management of this station by Masters W. C. Babcock and A. C. Baker, United States Navy, under whose direct care the hatching-house operations have been conducted.

Record of spawning operations conducted at Moxley's Point, on the Potomac, from April 19, 1882, to June 8, 1882, by B. G. Harris, spawn-taker.

Date.	Number of shad taken.	Number of herring taken.	Pounds of rock taken.	Ripe fish.		Eggs obtained.	Fish hatched.
				Males.	Females.		
1882.							1882.
April 19	*627	....	....	....	....	40,000	April 29.
20	707	....	....	....	....	155,000	April 30.
21	400	....	....	....	....	30,000	May 1.
22	286	....	....	....	....	205,000	May 2.
23	361	....	....	....	....	....	
24	493	....	....	....	....	500,000	May 3.
25	666	....	....	....	....	300,000	May 3.
26	360	....	....	....	....	500,000	May 4.
27	276	....	....	....	....	1,500,000	May 5, 6.
28	461	....	....	....	....	800,000	May 7.
29	283	....	....	....	....	300,000	May 8.
30	160	....	....	....	....	120,000	May 9.
May 1	360	....	....	....	....	445,000	May 10.
2	377	....	....	....	....	360,000	May 10.
3	182	....	....	....	....	280,000	May 11.
4	243	....	....	....	....	385,000	May 12.
5	288	....	....	....	....	730,000	May 13.
6	387	4,700	3	14	14	980,000	May 14.
7	248	13,000	13	15	12	500,000	May 15.
8	73	5,000	6	10	8	240,000	May 16.
9	56	7,000	....	5	4	110,000	May 18.
10	250	....	....	31	31	760,000	May 18.
11	90	....	....	2	1	....	
12	39	17,000	....	15	10	500,000	May 21.
13	71	3,000	....	16	12	400,000	May 22.
14	275	600	....	....	....	....	
15	170	1,000	....	15	12	50,000	(*)
16	44	1,500	....	16	13	350,000	May 23, 24.
17	214	2,000	....	13	10	280,000	May 25.
18	336	4,000	....	30	31	450,000	May 26.
19	128	8,000	....	3	3	400,000	May 27.
20	188	15,000	....	1	1	400,000	May 27.
21	62	18,000	....	2	2	40,000	May 28.
22	37	25,000	....	5	4	100,000	May 29.
23	16	5,000	3	2	2	40,000	May 30.
24	55	7,000	....	5	4	80,000	May 31.
25	40	2,000	....	2	3	70,000	June 1.
26	50	3,000	....	4	5	100,000	June 1.
27	137	5,000	....	6	6	200,000	June 2.
28	15	5,000	15	4	5	150,000	June 3.
29	40	7,000	6	10	12	300,000	June 4.
30	90	2,000	....	3	4	80,000	June 5.
31	175	1,000	....	....	....	....	
June 1	360	....	....	6	5	80,000	June 6.
2	....	....	....	....	....	....	
3	80	....	....	6	5	30,000	June 7.
4	20	....	....	....	....	....	
5	100	....	....	7	8	200,000	June 8.
6	130	....	....	4	3	80,000	June 9.
7	150	....	....	5	6	140,000	June 10.
8	115	....	....	5	5	120,000	June 10.

*Eggs transferred to Fish Hawk.

NOTE.—From April 19 to June 1 the length of haul-seines visited daily was 300 fathoms, and the length of gill-nets visited daily from June 3 to 8 was 5,200 fathoms.

Record of meteorological observations made at navy-yard, Washington, on the Eastern Branch of the Potomac, by Masters William C. Babcock and Asher C. Baker, United States Navy.

APRIL 25 TO MAY 11, 1882.

Date.		Temperature of—									Wind.						Condition of—				State of—			Remarks.
Day of week.	Day of month.	Air.	Surface water.	Bottom.	Air.	Surface water.	Bottom.	Air.	Surface water.	Bottom.	Direction.	Intensity.	Direction.	Intensity.	Direction.	Intensity.	Sky.	Sky.	Sky.	Water.	Tide.	Tide.	Tide.	
Tuesday	April 25	55	55	54	55	55	54	57	55	55	N.	1	W.	1	NE.	1	b. c.	b. c.	b. c.	Clear.	Ebb.	Low.	Flood.	Clear and cool.
Wednesday..	April 26	55	55	55	66	56	54	58	56	57	SE.	1	SE.	1	NE.	1–2	b. c.	c.	c. r.	..do ..	..do ..	Flood.	Ebb.	Cloudy and rainy.
Thursday....	April 27	55	55	55	52	55	55	62	56	56	NE.	1	N.	1	E.	3	o. c.	r.	b. c.	..do ..	..do ..	..do ..	..do ..	Partly cloudy, with light rain; changing to fair weather.
Friday.......	April 28	62	56	56	68	56	56	62	56	56	S.	1	S.	3	S.	1	c. m.	c.	b. c.	..do ..	Flood.	Ebb.	Flood.	Cloudy and warm.
Saturday ...	April 29	56	56	62	58	58	58	62	58	58	NE.	1	E.	2–3	E.	2	o. c.	o. c.	b. c.	..do ..	Ebb.	..do ..	Ebb.	Overcast; clearing after sunset.
Sunday	April 30	63	58	57	68	58	58	62	58	58	NW.	2–3	NW.	2–3	NW.	1	b. c.	b. c.	b. c.	..do ..	Flood.	..do ..	Flood.	Clear and pleasant.
Monday	May 1	58	58	58	71	59	61	68	59	59	Calm.	0	NW.	2–3	NW.	1–2	b. c.	b. c.	b. c.	..do ..	High.	..do ..	High.	Clear, warm, and pleasant.
Tuesday.....	May 2	64	60	59	66	59	61	56	59	59	NW.	2–4	N.	3–4	Calm.	0	b. c.	b. c.	b. c.	..do ..	..do ..	..do ..	Ebb.	Clear and warm; cool at night.
Wednesday..	May 3	56	58	59	64	59	59	62	60	59	N.	1	SW.	1–2	SW.	1–2	b.	b. r.	b. c.	..do ..	Flood.	..do ..	Flood.	Partly cloudy; cool weather.
Thursday....	May 4	64	60	60	70	61	60	72	60	60	S.	1–2	S.	2	SW.	1–2	b. c.	b. c.	b. c. p.	..do ..	..do ..	..do ..	..do ..	Partly cloudy; passing showers.
Friday.......	May 5	64	60	60	64	60	60	64	60	60	Var.	0–1	NE.	1–2	NE.	1–2	o. c. r.	o. c. r.	o. r.	..do ..	..do ..	Flood.	..do ..	Cloudy, cold, and rainy.
Saturday	May 6	59	60	60	58	60	60	59	59	59	NE.	1–2	NE.	2	NE.	1–2	o. c. d.	o. c. r.	o. c.	..do ..	..do ..	Ebb.	..do ..	Overcast and rainy.
Sunday	May 7	54	59	59	56	59	59	56	59	59	NE.	1–2	NE.	1	Calm.	0	o. r.	o. c. p.	o. c.	..do ..	..do ..	..do ..	..do ..	Overcast; passing showers.
Monday	May 8	56	58	58	60	58	58	59	58	58	NE.	1–2	NE.	1–2	NE.	1–2	o. c.	o. c. d.	o. c. p.	..do ..	..do ..	..do ..	..do ..	Do.
Tuesday	May 9	67	61	59	84	60	60	70	60	60	Calm.	0	S.	1	Calm.	0	b. c.	b. c.	b. c.	..do ..	Ebb.	Flood.	Ebb.	Clear and very warm.
Wednesday..	May 10	70	61	60	71	61	60	68	61	60	SE.	1	Calm.	0	Calm.	0	b. c.	o. d.	o. c.	..do ..	..do ..	..do ..	..do ..	Overcast and rainy.
Thursday ...	May 11	62	61	60	62	61	60	62	61	60	NE.	2–3	NE.	2	NE.	2	o. c. d.	o. c. r.	o. c. r.	..do ..	..do ..	..do ..	..do ..	Cold and rainy.

MAY 12 TO MAY 28, 1882.

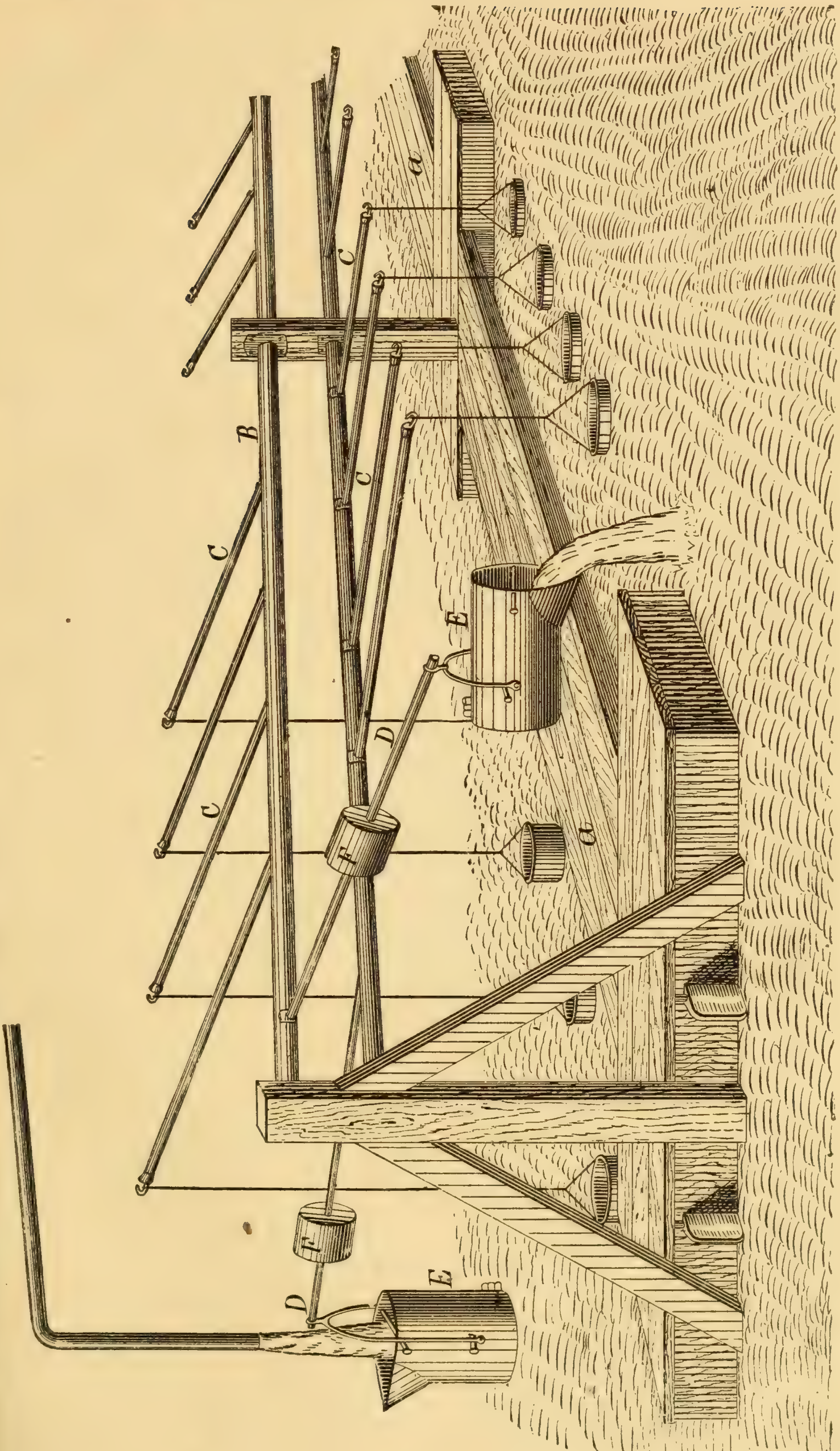
Friday.......	May 12	57	59	59	58	60	60	62	61	60	NE.	1	NE.	2	NE.	2	o. c.	o. c. d.	o. r.	Clear.	Ebb.	Flood.	Ebb.	Cold and rainy.
Saturday ...	May 13	56	60	60	58	60	60	58	60	60	NE.	1–2	NE.	2	NE.	2	o. r.	o. r.	o. r.	..do ..	..do ..	..do ..	..do ..	Do.
Sunday	May 14	58	59	60	60	59	59	60	59	59	NE.	1–2	NW.	1–2	NW.	2–3	o. r.	o. r.	o. r.	..do ..	..do ..	..do ..	..do ..	Do.

Monday	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	58	58	62	58	58	NE.	1–2	N.	1	Calm.	0	b. c.	o. c.	o. c. r.	..do..	Flood.	Ebb.	Flood.	Do.
Tuesday	May 16	59	58	58	64	59	59	63	58	58	NE.	1–2	N.	1–2	W.	2	o. c.	b. c.	o. c. p.	..do..	Ebb.	..do..	..do..	Cool and pleasant; light showers in the afternoon.
Wednesday	May 17	64	58	59	65	60	59	65	60	59	W.	2	N.	1	NE.	2	b. c.	b. c.	b. c.	..do..	..do..	Flood.	Ebb.	Cool and pleasant; light showers.
Thursday	May 18	62	59	59	66	59	59	63	59	59	Calm.	0	E.	1–2	E.	1–2	b. c.	b. c.	b. c.	..do..	High.	Ebb.	Flood.	Cloudy, cool, and pleasant.
Friday	May 19	57	59	60	57	59	60	58	59	59	NW.	1–2	N.	1	N.	1	b. c.	b. c.	b. c.	..do..	Ebb.	Flood.	..do..	Clear and pleasant.
Saturday	May 20	61	60	63	74	65	60	73	62	67	NE.	1–2	Calm.	0	E.	2–3	b. c.	b. c.	b. c.	..do..	..do..	Ebb.	..do..	Partially cloudy; warm and pleasant.
Sunday	May 21	70	64	64	78	61	64	70	62	61	NE.	1	Calm.	0	Calm.	0	b. c.	b. c.	b. c.	..do..	..do..	Flood.	..do..	Cloudy and warm.
Monday	May 22	72	63	63	74	63	70	74	63	70	Calm.	0	SW.	1–2	SW.	2–3	b. c.	b. c.	b. c.	..do..	Flood.	..do..	Ebb.	Cloudy; passing showers; raining heavily at night.
Tuesday	May 23	66	64	68	72	62	62	70	62	62	Calm.	0	W.SW	2	SW.	1	b. c.	b. c.	b. c.	..do..	..do..	..do..	..do..	Warm and pleasant.
Wednesday	May 24	72	64	68	76	65	70	72	65	70	SW.	2	SW.	2	SW.	2	b. c.	b. c.	b. c.	..do..	..do..	..do..	..do..	Do.
Thursday	May 25	72	64	68	75	65	70	74	65	70	W.	2	W.	2	W.SW	2	b. c.	b. c.	b. c.	..do..	..do..	..do..	..do..	Cloudy; clearing towards sunset.
Friday	May 26	70	65	68	76	65	68	70	65	68	SW.	1–2	SW.	1–2	W.	2	b. c.	b. c.	b. c.	..do..	..do..	..do..	..do..	Clear, warm, and pleasant.
Saturday	May 27	74	65	68	82	65	70	70	65	68	SW.	2	SW.	1	W.	2	b. c.	b. c.	b. c.	..do..	..do..	..do..	..do..	Do.
Sunday	May 28	74	65	69	83	67	72	74	67	72	SW.	2–3	SW.	3–4	SW.	2–5	b. c.	b. c.	b.c.q.r.	..do..	Ebb.	..do..	..do..	Partially clear; heavy rain squalls at 5.30 p. m.

MAY 29 TO JUNE 8, 1882.

Monday	May 29	75	65	71	80	67	72	75	67	72	NE.	1	NE.	1	NE.	1	b. c.	b. c.	b. c.	Clear.	Ebb.	Flood.	Ebb.	Clear and pleasant.
Tuesday	May 30	75	67	72	78	67	72	78	67	72	SW.	2	SW.	2–3	SW.	2–3	b. c.	b. c.	b. c.	..do..	..do..	..do..	..do..	Clear, warm, and pleasant.
Wednesday	May 31	77	68	72	82	68	73	78	69	72	SW.	3	S. SW.	3–4	S.	2–3	b. c.	b. c.	o. c. r.	..do..	..do..	..do..	..do..	Clear and warm; raining last hour; strong breeze from S. SW.
Thursday	June 1	74	69	73	80	69	72	80	69	72	S.	3	W.	2	W.	1–2	o. r.	b. c.	b. c.	..do..	..do..	..do..	..do..	Raining in the morning; clear, warm, and pleasant rest of day.
Friday	June 2	74	69	72	74	69	72	70	69	72	NW.	1	NW.	1	E.	1	b. c.	b. c.	b. c.	..do..	Flood.	..do..	..do..	Clear and pleasant.
Saturday	June 3	70	70	72	81	70	73	80	70	73	S.	2	SW.	2–3	E.	1–2	o. c.	b. c.	b. c.	..do..	..do..	Ebb.	Flood.	Partially clear, warm, and pleasant.
Sunday	June 4	77	70	74	77	70	74	72	70	73	NW.	2	NW.	2	NW.	2	b. c.	b. c.	b. c.	..do..	..do..	..do..	..do..	Clear and pleasant.
Monday	June 5	72	70	72	72	70	70	68	70	73	W.	2	W.	2–4	W.	1–2	b. c.	b. c.	b. c.	..do..	..do..	..do..	..do..	Cloudy and cool; light to fresh breeze from the westward.
Tuesday	June 6	74	70	71	76	70	71	68	70	71	NW.	2	NW.	2	NW.	0–1	b. c.	b. c.	b. c.	..do..	..do..	..do..	..do..	Clear and pleasant.
Wednesday	June 7	74	70	72	85	70	72	75	70	72	S.	2	S.	1	S.	2	b. c.	b. c.	b. c.	..do..	Ebb.	Flood.	..do..	Do.
Thursday	June 8	79	71	73	84	71	73	73	71	74	S.	1	S.	1	SW.	1	b. c.	b. c.	b. c.	..do..	..do..	..do..	..do..	Do.

The hours of observation were 7 a. m., noon, and 9 p. m. daily.



Apparatus for operating shad-hatching cylinders.

XXXVI.—DISTRIBUTION OF SHAD THROUGH CENTRAL STATION BY THE UNITED STATES FISH COMMISSION IN 1882.

By M. McDonald.

In anticipation of the increased demand for shad fry for planting in new waters extensive preparations were made to utilize to the fullest extent the resources of the Potomac and Susquehanna Rivers. In consequence of the low temperature of water prevailing during the season in both these rivers the catch of shad was unexpectedly small, and the river fisheries were comparatively a failure. The same conditions which influenced unfavorably the catch affected also the number and quality of eggs secured. The total number of fry obtained for distribution amounted to 20,637,000. Of these 800,000 were furnished by the station on the Susquehanna River, near Havre de Grace, Md., and the balance by the Potomac River stations; the Navy-Yard contributing 14,444,000 and Central Station 5,393,000.

For convenience of reference a summary of distribution arranged alphabetically by waters is also appended.

The distribution was made mainly by car service, one distinguishing feature of the season being the concentration of large numbers of fish in single plants in comparatively few localities.

The total mileage of the cars in making this distribution was for car No. 1, in charge of Mr. George H. H. Moore, 9,730 miles, and car No. 2, in charge of Mr. J. Frank Ellis, 2,462 miles.

Of the entire number planted 6,110,000 were placed in the Mississippi River or its tributaries, and 5,440,000 in the minor tributaries of the Gulf of Mexico.

TABLE I.—*Record of distribution of shad made from May* 3, 1882, *to June* 17, 1882, *from Central Station, under direction of Marshall McDonald.*

Date of transfer.	Number of fish.		Introduction of fish.	
	Originally taken.	Actually planted.	Place.	Stream.
May 3	475,000	450,000	Tiffin, Ohio	Sandusky River.[3]
4	500,000	500,000	Little Falls, Md	Potomac River.[10]
5	430,000	430,000	Little Falls, Md	Potomac River.[10]
6	200,000	200,000	Little Falls, Md	Potomac River.[5]
7	250,000	240,000	Wheeling, W. Va	Ohio River.[10]
8	250,000	231,000	Newnan, Ga	Chattahoochee River.[1]
8	750,000	750,000	Little Falls, Md	Potomac River.[5]
9	300,000	300,000	Va. Mid. R. R. Crossing	Rappahannock River.[9]
11	1,000,000	870,000	Austin, Tex	Colorado River.[3]
12	300,000	300,000	Farmville, Va	Appomattox, River.[2]
12	250,000	248,000	C. and A. A. L. Crossing, South Carolina.	Broad River.[4]
13	470,000	470,000	Fredericksburg, Va	Rappahannock River.[9]
13	300,000	300,000	Strasburg, Va	Shenandoah River.[8]
13	550,000	550,000	Little Falls, Md	Potomac River.[1]
15	*600,000	450,000	Conyers, Ga	Oconee River.[8]
15	600,000	450,000	Covington, Ga	Yellow River.[8]
17	250,000	249,000	C. and A. A. L. Crossing, South Carolina.	Broad River.[4]
18	800,000	800,000	Towers, Ky	Kentucky River.[10]
18	800,000	800,000	Point Burnside, Ky	Cumberland River.[10]
19	400,000	400,000	Chattanooga, Tenn	Tennessee River.[1]
20	24,000	20,000	New York City.[12]	
21	400,000	400,000	Little Falls, Md	Potomac River.[5]
21	325,000	325,000	Junction of Etowah and Oostanaula Rivers, Ga.	Coosa River.[8]
21	350,000	350,000	2 miles from Rome, Ga	Etowah River.[8]
21	325,000	325,000	3 miles from Rome, Ga	Oostanaula River.[8]
22	300,000	300,000	Zanesville, Ohio	Muskingum River.[6]
22	545,000	545,000	Columbus, Ohio	Scioto River.[6]
22	300,000	300,000	Athens, Ohio	Hocking River.[6]
24	893,000	893,000	Albany, N. Y	Hudson River.[10]
27	250,000	250,000	Selma, Ala	Catawba River.[1]
27	300,000	300,000	Troy, Ala	Conecuh River.[2]
27	300,000	300,000	Whiting, Ala	Escambia Creek.[2]
27	200,000	200,000	Atlanta, Ga	Chattahoochee River.[2]
27	250,000	250,000	West Point, Ga	Chattahoochee River.[2]
28	300,000	300,000	Little Falls, Md	Potomac River.[5]
28	240,000	216,000	Poplar Bluff, Ark	Black River.[6]
28	248,000	216,000	Arkadelphia, Ark	Ouachita River.[6]
28	370,000	306,000	Jefferson, Tex	Cyprus Bayou.[6]
28	370,000	342,000	Fort Worth, Tex	Trinity River.[6]
30	688,000	688,000	Little Falls, Md	Potomac River.[5]
31	100,000	100,000	Shepherdsville, Ky	Salt River.[8]
31	100,000	100,000	Munfordville, Ky	Green River.[8]
31	100,000	100,000	Bowling Green, Ky	Barren River.[8]
June 1	891,000	891,000	Seaford, Del	Nanticoke River.[3]
2	145,000	142,000	Ellsworth, Kans	Smoky Hill River.[1]
2	20,000	20,000		Saline River.[1]
2	20,000	20,000		Solomon River.[1]
2	20,000	20,000		Republican River.[1]
2	20,000	20,000		Blue River.[1]
3	958,000	958,000	Dubuque, Iowa	Mississippi River.[3]
3	*150,000	145,000	Covington, Ind	Wabash River.[2]
3	*150,000	145,000	Danville, Ill	Kaskaskie River.[2]
5	210,000	210,000	Piedmont, W. Va	Potomac River.[11]
6	125,000	125,000	Quitman Ga	Withlacoochee River.[8]
6	125,000	125,000		Flint River.[8]

TABLE I.—*Record of distribution of shad, &c.*—Continued.

Date of transfer.	Number of fish.		Introduction of fish.	
	Originally taken.	Actually planted.	Place.	Stream.
June 7	340,000	340,000	Charlottesville, Va	Rivanna River.[9]
10	70,000	70,000	Albany, N. Y	Hudson River.[7]
13	140,000	140,000	Fredericksburg, Va	Rappahannock River.[6]
17	*250,000	237,500	Waterville, Me	Sebastacook River.[6]
17	*250,000	237,500	Mattawamkeag, Me	Mattawamkeag River.[6]
Total	20,637,000	19,950,000		

NOTE.—Of the above 14,444,000 were hatched at the Navy-Yard Station, 5,393,000 at Central Station, and 800,000 (indicated by the *) at the Havre de Grace Station, on the Susquehanna River.

The messengers in charge, as denoted by figures in the table, were as follows: [1] G. G. Davenport, [2] F. L. Donnelly, [3] J. F. Ellis (car No. 2), [4] C. J. Huske, [5] J. Mace, [6] G. H. H. Moore (car No. 1), [7] W. F. Page, [8] H. E. Quinn, [9] G. C. Schuermann, [10] N. Simmons, [11] W. D. Wirt, [12] B. and O. express.

TABLE 2.—*Record of distribution of shad from May* 3 *to June* 17, 1882. *Arranged alphabetically by waters.*

Date of deposit.	Waters stocked.	Point of deposit.	No. of fish deposited.
May 12	Appomattox River	Farmville, Va	*[2] 300,000
28	Black River	Poplar Bluff, Ark	[6] 240,000
June 2	Blue River	Ellsworth, Kans	[1] 25,000
May 12–17	Broad River	C. & A. & L. R. R. Crossing, S. C.	[4] 500,000
27	Burnt Corn Creek	Brewton, Ala	[2] 100,000
27	Catawba River	Selma, Ala	[3] 250,000
31	Barren River	Bowling Green, Ky	[8] 100,000
27	Chattahoochee River	West Point, Ga	[2] 200,000
27	......do	Atlanta, Ga	[2] 250,000
8	......do	West Point, Ga	[1] 250,000
16	Colorado River	Austin, Tex	[3] 1,070,000
27	Conecuh River	Near Troy, Ala	[2] 300,000
21	Coosa River	Rome, Ga	[8] 350,000
18	Cumberland River	Point Burnside, Ky	[10] 800,000
28	Cypress Bayou	Jefferson, Tex	[6] 360,000
27	Escambia River	Brewton, Ala	[2] 100,000
21	Etowah River	Cartersville, Ga	[8] 350,000
June 6	Flint River	Albany, Ga	[8] 125,000
May 31	Green River	Munfordville, Ky	[8] 100,000
24	Hocking River	Athens, Ohio	[6] 300,000
24	Hudson River	Troy, N. Y	[10] 1,000,000
June 11	......do	......do	[7] 70,000
3	Vermillion River	Danville, Ill	[2] 150,000
May 18	Kentucky River	High Bridge, Ky	[10] 800,000
June 17	Mattawamkeag River	Mattawamkeag, Me	[6] 250,000
3	Mississippi River	Dubuque, Iowa	[3] 958,000
May 27	Murder Creek	Near Sparta, Ala	[2] 100,000
22	Muskingum River	McConnellsville, Ohio	[6] 300,000
June 1	Nanticoke River	Seaford, Del	[3] 891,000
May 20	Oconee River	Conyers, Ga	[8] 450,000
7	Ohio River	Wheeling, W. Va	[10] 250,000

TABLE 2.—*Record of distribution of shad, &c.*—Continued.

Date of deposit.		Water stocked.	Point of departure.	No. of fish deposited.
May	28	Ouchita River	Arkadelphia, Ark	[6]240,000
	21	Oostanaula River	Resaca, Ga	[8]300,000
	28	Potomac River	Little Falls, Md	[5]300,000
	30	......do	......do	[5]6[illegible]8,000
	21	......do	......do	[5]400,000
	4	......do	......do	[10]500,000
	13	......do	......do	[1]550,000
	5	......do	......do	[10]430,000
June	5	......do	Piedmont, W. Va	[11]210,000
May	13	Rappahannock River	Fredericksburg, Va	[9]470,000
	12	......do	Va. Mid. R. R. Crossing	[9]300,000
June	13	......do	Fredericksburg, Va	[6]140,000
	2	Republican River	Ellsworth, Kans	[1]25,000
	7	Rivanna River	Charlottesville, Va	[9]340,000
	2	Saline River	Ellsworth, Kans	[1]25,000
May	31	Salt River	Shepherdsville, Ky	[8]100,000
	3	Sandusky River	Tiffin, Ohio	[3]475,000
	29	Sangamon River	Near Havana, Ill	[6]552,000
	22	Scioto River	Columbus, Ohio	[6]545,000
June	17	Sebastacook River	Waterville, Me	[6]250,000
May	13	Shenandoah River	Strausburg, Va	[8]300,000
June	2	Smoky Hill River	Ellsworth, Kans	[1]200,000
	2	Solomon River	......do	[1]25,000
May	19	Tennessee River	Chattanooga, Tenn	[1]400,000
	28	Trinity River	Fort Worth, Tex	[6]360,000
June	3	Wabash River	Covington, Ind	[2]150,000
	6	Withlacoochee River	Between Quitman and Valdosta, Ga	[8]125,000
May	20	Yellow River	Covington, Ga	[8]450,000
				20,130,000

* The names of messengers as indicated by these figures were as follows: [1] G. G. Davenport, [2] F. L. Donnelly, [3] J. F. Ellis (car No. 2), [4] C. J. Huske, [5] J. Mace, [6] G. H. H. Moore (car No. 1), [7] W. F. Page, [8] H. E. Quinn, [9] G. C. Schuermann, [10] N. Simmons, [11] W. D. Wirt.

XXXVII.—STATISTICS OF THE SHAD-HATCHING OPERATIONS CONDUCTED BY THE UNITED STATES FISH COMMISSION IN 1882.

By Chas. W. Smiley.

From the reports of the various persons in charge of shad-hatching stations during the spring of 1882, I have prepared a series of five tables to show the operations at each station, and the sixth for a summary exhibit. From these it will appear that 36,637,000 eggs were obtained and hatched with an average loss of 18 per cent. A comparison with the number of shad hatched in previous years is of interest. The decrease this year has been attributed to the cold season and small run of shad.

Number of shad hatched:

1879	16,842,000
1880	29,473,000
1881	70,035,000
1882	30,283,000

Of the fish hatched, a part were deposited in waters near the several hatching stations, as follows:

Deposited in local waters:

1879	5,587,000
1880	7,864,600
1881	46,518,500
1882	8,315,000

Of the fish hatched, the number designed for transportation to other waters was as follows:

Placed in transportation for other waters:*

1879	10,002,500
1880	20,761,400
1881	23,516,500
1882	†21,078,000

The number of shad actually deposited within the waters of the different States the present year was as follows:

Alabama	850,000
Arkansas	432,000
Delaware	891,000
District of Columbia	3,050,000
Georgia	2,831,000
Illinois	145,000

* From these figures there is a slight deduction each year for fish lost in transit.

† Of these 677,000 were lost while in transit.

Indiana	145,000
Iowa	958,000
Kansas	222,000
Kentucky	1,900,000
Maine	475,000
Maryland	7,769,000
New York	983,000
Ohio	1,595,000
South Carolina	497,000
Tennessee	400,000
Texas	1,518,000
Virginia	3,605,000
West Virginia	450,000
Total	28,716,000

Fuller particulars of these deposits, the time, streams, places, etc. will be found in the tables of distribution.

TABLE I.—*Record of shad-hatching operations conducted by the United States steamer Fish Hawk, Lieut. Z. L. Tanner, U. S. N., commanding, at Quantico Creek, from April* 17 *to May* 22, 1882.

Date.	Ripe shad taken.		Eggs obtained.	Eggs lost in hatching.	Fish released in local waters.	Fish transported to other places.
	Males.	Females.				
Apr. 17	1	1	20,000			
18	1	1	30,000			*30,000
19	1	1	30,000			
20	1	1	20,000			
24	4	1	15,000			
26	1	1	25,000		20,000	
28	1	1	15,000			
29	1	1	15,000			
29	4	3	147,000			
30	4	6	175,000	60,000		
30	11	8	280,000	25,000		
May 1	5	3	50,000	5,000		
1	15	15	400,000	10,000		
2	5	5	150,000	25,000		
2	11	11	275,000			
3	9	9	125,000		30,000	
3	6	6	130,000			
4	2	2	50,000		20,000	
4	3	3	70,000			
5	2	2	40,000			
5	1	1	35,000			
6	8	8	255,000	5,000		
7	1	1	15,000	2,000	15,000	
7					25,000	
8					15,000	
8					15,000	
8					147,000	
9					115,000	
9					255,000	
9					45,000	
10					125,000	
11					390,000	†600,000
11					455,000	
12					50,000	†200,000
12					13,000	
14	3	3	‡40,000	20,000		
22					20,000	
Total	101	94	2,407,000	152,000	1,755,000	830,000

* Used for experiments.
† Transferred to central station and navy-yard, and included in the reports for those places.
‡ Eggs received from the Lookout.

TABLE II.—*Record of shad-hatching operations conducted by the United States Fish Commission at Moxley's Point, and navy-yard, Washington, D. C., from April 19 to June 8, 1882, inclusive. Lieut. W. M. Wood in charge.*

Date.	Ripe shad taken.		Eggs obtained.	Eggs lost in hatching.	Fish released in local waters.	Transported to other waters.	Messenger in charge of transfer.
	Males.	Females.					
1882.							
Apr. 19	....	....	40, 000	....	....	....	
20	....	....	155, 000	....	....	....	
21	....	....	30, 000	....	....	....	
22	....	....	205, 000	....	....	....	
23	....	....	....	....	....	....	
24	....	....	500, 000	....	....	....	
25	....	....	300, 000	....	....	....	
26	....	....	500, 000	....	....	....	
27	....	....	1, 500, 000	....	....	....	
28	....	....	800, 000	....	....	....	
29	....	....	300, 000	....	....	....	
30	....	....	120, 000	....	....	....	
May 1	....	....	445, 000	....	....	....	
2	....	....	360, 000	....	....	....	
3	....	....	280, 000	....	....	150, 000	J. F. Ellis.
4	....	....	385, 000	....	....	300, 000	N. Simmons.
5	....	....	730, 000	....	....	230, 000	Do.
6	14	14	980, 000	....	....	....	
7	15	12	500, 000	....	....	250, 000	G. G. Davenport.
8	10	8	240, 000	....	....	450, 000	J. Mace.
9	5	4	110, 000	....	....	300, 000	G. Schuermann.
10	30	31	760, 000	....	....	250, 000	C. J. Huske.
11	2	1	....	....	....	750, 000	J. F. Ellis.
12	15	10	500, 000	....	....	300, 000	H. E. Quinn.
13	16	12	400, 000	....	....	550, 000	G. G. Davenport,
14	....	....	....	....	....	250, 000	G. Schuermann.
15	15	12	50, 000	....	....	859, 000	H. E. Quinn.
16	16	13	350, 000	....	....	....	
17	13	10	280, 000	....	....	250, 000	C. J. Huske.
18	30	30	450, 000	....	....	1, 400, 000	N. Simmons.
19	3	3	400, 000	....	....	....	
20	1	1	400, 000	....	....	....	
21	2	2	40, 000	....	....	1, 000, 000	H. E. Quinn,
22	5	4	100, 000	....	....	1, 005, 000	G. H. H. Moore.
23	2	2	40, 000	....	....	....	
24	5	4	80, 000	....	....	810, 000	N. Simmons.
25	2	3	70, 000	....	....	....	
26	4	5	100, 000	....	....	920, 000	F. L. Donnelly.
27	6	6	200, 000	....	....	250, 000	G. G. Davenport.
28	4	5	150, 000	....	....	920, 000	G. H. H. Moore.
29	10	12	300, 000	....	....	300, 000	J. Mace.
30	3	4	80, 000	....	....	480, 000	Do.
31	....	....	....	....	....	560, 000	J. F. Ellis.
June 1	6	5	80, 000	....	....	300, 000	H. E. Quinn.
3	5	5	30, 000	....	....	910, 000	J. F. Ellis.
5	7	8	200, 000	....	....	180, 000	W. D. Wirt.
6	4	3	80, 000	....	....	180, 000	H. E. Quinn.
7	5	6	140, 000	....	....	340, 000	G. Schuermann.
8	5	5	120, 000	....	....	....	
April to June.	....	....	7, 940, 000	....	....	*441, 000	
Total..	....	....	21, 820, 000	3, 885, 000	3, 050, 000	14, 885, 000	

* Sent directly to Little Falls of the Potomac River.

TABLE III.—*Record of shad-hatching operations conducted by H. C. Chester, at Havre de Grace, Md., on the Susquehanna River, under the direction of the United States Fish Commission, from May 8 to June 23, inclusive,* 1882.

Date.	Ripe shad taken.		Eggs obtained.	Eggs lost.	Fish released in local waters.	Fish transported to other waters.	Fish taken at seine hauls.			
	Males.	Females.					Shad.	Herring.	Rock.	Others.
1882.										
May 8			18,000							
9			359,000							
10			473,000	*473,000						
†18			156,000							
19			145,000							
20			135,000				4	700		500
21			60,000							
22			25,000				70	800	1	1,500
23			477,000				150	2,000	1	1,000
24			170,000				100	1,000		
25			239,000		400,000		48	600		
26							100	500		
27			215,000							
31					1,000,000					
June 1					300,000					
2					150,000		27	400		
3							12	300		
5					75,000	150,000	16			
6			‡105,000				47			
7			‡117,000				26	300	4	
8	‡11	‡12	‡317,000				47		10	
9	‡6	‡6	‡117,000				26		14	
10							26		8	
12	‡2		‡25,000				6		26	
13							6		39	
14							6		7	
15				‡75,000	30,000	500,000	12		14	
16							2		5	
17							4		4	
19							11		12	
21							12		2	
23									36	
Total..			3,153,000	548,000	1,955,000	650,000	758	6,600	183	3,000

* Loss of these eggs caused by a gale.
† From May 11 to 17 it was not possible to operate the fisheries on account of high winds.
‡ From fish in the pool.

TABLE IV.—*Record of shad-hatching operations conducted by the United States steamer Fish Hawk, Lieut. Z. L. Tanner, U. S. N., commanding, near Battery Station, Susquehannah River, May* 23 *to June* 13, 1882.

Date.	Shad taken.		Eggs obtained.	Eggs lost in hatching.	Fish released in local waters.	Fish transported to other waters.
	Males.	Females.				
May 23	11	11	336, 000			
23	7	8	170, 000			
24	6	7	147, 000			
24	5	5	154, 000			
24	6	7	185, 000			
25	10	7	215, 000			
26	3	2	77, 000			
27	1	1	35, 000			
27	2	3	60, 000			
27	2	1	40, 000			
29	15	13	364, 000			
30	10	8	220, 000			
30	3	5	112, 000			
30	2	2	84, 000			
30	6	5	112, 000			
31					300, 000	
June 1					200, 000	
2	2	1	40, 000		668, 000	
5						150, 000
6	1	1	10, 000			
6	1	1	25, 000			
6	1	2	40, 000			
8	2	3	100, 000			
9					387, 000	
12	1	1	*25, 000			
13						†60, 000
Total	97	94	2, 551, 000	761, 000	1, 555, 000	210, 000

* Turned over to Battery Station to hatch. † Final destination not reported.

TABLE V.—*Record of shad-hatching operations conducted under the direction of M. McDonald at Central Station, Washington, D. C., from April 27 to June 19, 1882, inclusive.*

Date.	Eggs received.	Eggs lost in hatching.	Fish furnished for transportation to other waters.	Messenger in charge of transfer.
April 27	1,772,000			
28	285,000			
29	305,000			
30	320,000			
May 1	125,000			
2	160,000	200,000		
3	55,000	425,000	325,000	J. F. Ellis.
4	142,000	35,000	200,000	N. Simmons.
5	214,000	60,000	200,000	Do.
6	75,000		200,000	J. Mace.
7	211,000	79,000	250,000	N. Simmons.
8	205,000	18,000	300,000	J. Mace.
9	362,000			
10	142,000			
11	225,000	*63,000	250,000	J. F. Ellis.
12	90,000		300,000	F. L. Donnelly.
13	20,000		220,000	G. Schurmann.
14	40,900	*70,000		
15	15,000		341,000	H. E. Quinn.
16	103,000	37,000		
17	20,000	27,000	200,000	N. Simmons.
18	82,000	37,000	400,000	G. G. Davenport.
19	145,000			
20	105,000	22,000	24,000	B. & O. Express.
21	158,000	72,000	400,000	J. Mace.
22	15,000	31,000	140,000	G. H. H. Moore.
23	230,000			
24	235,000		83,000	N. Simmons.
25	40,000	22,000		
26	246,000	8,000	130,000	F. L. Donnelly.
27	30,000	6,000		
28	25,000	32,000	308,000	G. H. H. Moore.
30	119,000		208,000	J. Mace.
31		22,000	331,000	J. F. Ellis.
June 1	25,000	37,000	225,000	G. G. Davenport.
2	10,000	25,000		
3			48,000	J. F. Ellis.
4		70,000		
5	68,000		30,000	W. D. Wirt.
6	105,000	12,000	70,000	H. E. Quinn.
7	65,000			
8	27,000			
9		2,000	70,000	W. F. Page.
10		6,000		
12			140,000	G. H. H. Moore.
13	70,000	18,000		
14	10,000	*10,000		
15	10,000			
18		9,000		
19		1,000		
Total	6,706,000	1,313,000	5,393,000	

* Loss offset by overcount of eggs received.

TABLE VI.—*Summary of work at shad-hatching stations operated by the United States Fish Commission during the spring of 1882.*

Dates.		Location of stations.		Persons in charge of station.	Eggs obtained.	Eggs lost.	Fish hatched.	Fish released in local waters.	Fish transported to other waters.
Season began.	Season ended.	Water.	Place.						
April 17	May 22	Quantico Creek	Quantico, Va.	Z. L. Tanner	2, 407, 000	152, 000	2, 585, 000	1, 755, 000	*830, 000
April 19	June 8	Moxley's Point	Navy-yard, Washington	W. M. Wood	21, 820, 000	3, 885, 000	17, 935, 000	3, 050, 000	14, 885, 000
May 8	June 23	Battery Island	Havre de Grace, Md	H. C. Chester	3, 153, 000	548, 000	2, 605, 000	1, 955, 000	650, 000
May 23	June 13	Susquehanna River	Havre de Grace, Md	Z. L. Tanner	2, 551, 000	761, 000	1, 765, 000	1, 555, 000	†210, 000
April 27	June 19	Central Station	Washington, D. C.	M. McDonald	6, 706, 000	1, 313, 000	5, 393, 000	....	5, 393, 000
		Total			36, 637, 000	6, 659, 000	‡30, 283, 000	8, 315, 000	‡21, 968, 000

* Of this number 30,000 were used for experiments; 600,000 were delivered to Central Station and 200,000 to navy-yard, and included in the reports for those stations.

† Of this number 60,000 were reported as a shipment, but no further record appears.

‡ Of this amount 30,000 were used for experiment, and 800,000 are duplicated in the reports of Central Station and navy-yard. The disposition of the remainder, with the exception of the 60,000 referred to in the preceding foot-note, appears from Tables VII and VIII.

TABLE VII.—*Chronological record of distribution of young shad made under the direction of the United States Commissioner of Fish and Fisheries, from April 26 to June 17, 1882.*

Date.	Where fish were hatched.	Number of fish—		Introduction of fish.				Transfer in charge of—
		Started with.	Actually planted.	State.	Town or place.	Stream.	Tributary of—	
1882.								
April 26	Steamer Fish Hawk	20,000	20,000	Virginia	Quantico	Quantico Creek	Potomac River	Z. L. Tanner.
April & May.	Navy-yard	3,050,000	3,050,000	Dist. of Columbia	Washington	Eastern Branch	Potomac River	W. M. Wood.
May 3	Steamer Fish Hawk	30,000	30,000	Virginia	Quantico	Quantico Creek	Potomac River	Z. L. Tanner.
3	Navy-yard and armory	475,000	450,000	Ohio	Tiffin	Sandusky River	Ohio River	J. F. Ellis.
4	Steamer Fish Hawk	20,000	20,000	Virginia	Quantico	Quantico Creek	Potomac River	Z. L. Tanner.
4	Navy-yard and armory	500,000	500,000	Maryland	Little Falls	Potomac River	Chesapeake Bay	N. Simmons.
5	Navy-yard and armory	430,000	430,000	Maryland	Little Falls	Potomac River	Chesapeake Bay	N. Simmons.
6	Armory	200,000	200,000	Maryland	Little Falls	Potomac River	Chesapeake Bay	Joseph Mace.
7	Armory	250,000	240,000	West Virginia	Wheeling	Ohio River	Mississippi River	N. Simmons.
7	Steamer Fish Hawk	40,000	40,000	Virginia	Quantico	Quantico Creek	Potomac River	Z. L. Tanner.
8	Steamer Fish Hawk	177,000	177,000	Virginia	Quantico	Quantico Creek	Potomac River	Z. L. Tanner.
8	Navy-yard	250,000	231,000	Georgia	Newman	Chattahoochee River	Appalachicola River	G. G. Davenport.
8	Navy-yard and armory	750,000	750,000	Maryland	Little Falls	Potomac River	Chesapeake Bay	Joseph Mace.
9	Navy-yard	300,000	300,000	Virginia	Va. Midland R. R. Crossing.	Rappahannock River	Chesapeake Bay	G. C. Schuermann.
9	Steamer Fish Hawk	415,000	415,000	Virginia	Quantico	Quantico Creek	Potomac River	Z. L. Tanner.
10	Steamer Fish Hawk	125,000	125,000	Virginia	Quantico	Quantico Creek	Potomac River	Z. L. Tanner.
11	Steamer Fish Hawk	845,000	845,000	Virginia	Quantico	Quantico Creek	Potomac River	Z. L. Tanner.
11	Navy-yard and armory	1,000,000	870,000	Texas	Austin	Colorado River	Gulf of Mexico	J. F. Ellis.
12	Steamer Fish Hawk	63,000	63,000	Virginia	Quantico	Quantico Creek	Potomac River	Z. L. Tanner.
12	Armory	300,000	300,000	Virginia	Farmville	Appomattox River	James River	F. L. Donnelly.
12	Navy-yard	250,000	248,000	South Carolina	C. and A. A. L. Crossing.	Broad River	Santee River	C. J. Huske.
13	Navy-yard and armory	470,000	470,000	Virginia	Fredericksburg	Rappahannock River	Chesapeake Bay	G. C. Schuermann.
13	Navy-yard	300,000	300,000	Virginia	Strasburg	Shenandoa River	Potomac River	H. E. Quinn.
13	Navy-yard	550,000	550,000	Maryland	Little Falls	Potomac River	Chesapeake Bay	G. G. Davenport.
15	Navy-yard and armory	600,000	450,000	Georgia	Conyers	Oconee River	Altamoha River	H. E. Quinn.
15	Navy-yard and armory	600,000	450,000	Georgia	Covington	Yellow River	Ocmulgee River	H. E. Quinn.
17	Navy-yard	250,000	249,000	South Carolina	C. and A. A. L. Crossing.	Broad River	Santee River	C. J. Huske.
18	Navy-yard	800,000	800,000	Kentucky	Towers	Kentucky River	Ohio River	N. Simmons.
18	Navy-yard and armory	800,000	800,000	Kentucky	Point Burnside	Cumberland River	Ohio River	N. Simmons.
19	Armory	400,000	400,000	Tennessee	Chattanooga	Tennessee River	Ohio River	G. G. Davenport.
20	Armory	24,000	20,000	New York	New York	East River	Atlantic Ocean	B. and O. Express.
21	Armory	400,000	400,000	Maryland	Little Falls	Potomac River	Chesapeake Bay	Joseph Mace.
21	Navy-yard	325,000	325,000	Georgia	Junction of Etowah and Oostenaula Rivers.	Coosa River	Mobile River	H. E. Quinn.

	21	Navy-yard	350,000	350,000	Georgia	2 miles from Rome	Etowah River	Coosa River	H. E. Quinn.
	21	Navy-yard	325,000	325,000	Georgia	3 miles from Rome	Oostenaula River	Coosa River	H. E. Quinn.
	22	Steamer Fish Hawk	20,000	20,000	Virginia	Quantico	Quantico Creek	Potomac River	Z. L. Tanner.
	22	Navy-yard and armory	300,000	300,000	Ohio	Zanesville	Muskingum River	Ohio River	G. H. H. Moore.
	22	Navy-yard and armory	545,000	545,000	Ohio	Columbus	Sciota River	Ohio River	G. H. H. Moore.
	22	Navy-yard and armory	300,000	300,000	Ohio	Athens	Hockhocking River	Ohio River	G. H. H. Moore.
	24	Navy-yard and armory	893,000	893,000	New York	Albany	Hudson River	Atlantic Ocean	N. Simmons.
	25	Havre de Grace	400,000	400,000	Maryland	Battery Island	Susquehanna River	Chesapeake Bay	H. C. Chester.
	27	Navy-yard	250,000	250,000	Alabama	Selma	Alabama River	Mobile River	G. G. Davenport.
	27	Navy-yard	300,000	300,000	Alabama	Troy	Conecuh River	Escambia River	F. L. Donnelly.
	27	Navy-yard	300,000	300,000	Alabama	Whiting	Escambia Creek	Gulf of Mexico	F. L. Donnelly.
	27	Navy-yard	200,000	200,000	Georgia	Atlanta	Chattahoochee River	Appalachicola River	F. L. Donnelly.
	27	Navy-yard and armory	250,000	250,000	Georgia	West Point	Chattahoochee River	Appalachicola River	F. L. Donnelly.
	28	Navy-yard	300,000	300,000	Maryland	Little Falls	Potomac River	Chesapeake Bay	Joseph Mace.
	28	Navy-yard	240,000	216,000	Arkansas	Poplar Bluffs	Black River	White River	G. H. H. Moore.
	28	Navy-yard	248,000	216,000	Arkansas	Arkadelphia	Washita River	Red River	G. H. H. Moore.
	28	Navy-yard	370,000	306,000	Texas	Jefferson	Big Cypress Creek	Caddo Lake	G. H. H. Moore.
	28	Navy-yard and armory	370,000	342,000	Texas	Fort Worth	Trinity River	Trinity Bay	G. H. H. Moore.
	30	Navy-yard and armory	688,000	688,000	Maryland	Little Falls	Potomac River	Chesapeake Bay	Joseph Mace.
	31	Navy-yard	100,000	100,000	Kentucky	Shepherdsville	Salt River	Ohio River	H. E. Quinn.
	31	Navy-yard	100,000	100,000	Kentucky	Mumfordville	Green River	Ohio River	H. E. Quinn.
	31	Navy-yard	100,000	100,000	Kentucky	Bowling Green	Barren River	Green River	H. E. Quinn.
	31	Havre de Grace	1,000,000	1,000,000	Maryland	Battery Island	Susquehanna River	Chesapeake Bay	H. C. Chester.
	31	Steamer Fish Hawk	300,000	300,000	Maryland	Havre de Grace	North East River	Susquehanna River	Z. L. Tanner.
	1–31	Navy-yard	441,000	441,000	Maryland	Little Falls	Potomac River	Chesapeake Bay	Joseph Mace (?).
June	1	Steamer Fish Hawk	200,000	200,000	Maryland	Havre de Grace	North East River	Susquehanna River	Z. L. Tanner.
	1	Havre de Grace	300,000	300,000	Maryland	Battery Island	Susquehanna River	Chesapeake Bay	H. C. Chester.
	2	Havre de Grace	150,000	150,000	Maryland	Battery Island	Susquehanna River	Chesapeake Bay	H. C. Chester.
	1	Navy-yard and armory	891,000	891,000	Delaware	Seaford	Nanticoke River	Chesapeake Bay	J. F. Ellis.
	2	Steamer Fish Hawk	668,000	668,000	Maryland	Havre de Grace	North East River	Susquehanna River	Z. L. Tanner.
	2	Armory	75,500	74,000	Kansas	Ellsworth	Smoky Hill River	Kansas River	G. G. Davenport.
	2	Armory	37,500	37,000	Kansas	New Cambria	Sabine River	Smoky Hill River	D. B. Long.
	2	Armory	37,500	37,000	Kansas	Solomon City	Solomon River	Kansas River	D. B. Long.
	2	Armory	37,500	37,000	Kansas	Fort Riley	Republican River	Kansas River	D. B. Long.
	2	Armory	37,500	37,000	Kansas	Manhattan	Big Blue River	Kansas River	D. B. Long.
	3	Navy-yard and armory	958,000	958,000	Iowa	Dubuque	Mississippi River	Gulf of Mexico	J. F. Ellis.
	3	Fish Hawk	150,000	145,000	Indiana	Covington	Wabash River	Ohio River	F. L. Donnelly.
	3	Battery Island	150,000	145,000	Illinois	Danville	Big Vermillion River	Mississippi River	F. L. Donnelly.
	5	Havre de Grace	75,000	75,000	Maryland	Battery Island	Susquehanna River	Chesapeake Bay	H. C. Chester.
	5	Navy-yard and armory	210,000	210,000	West Virginia	Piedmont	Potomac River	Chesapeake Bay	W. D. Wirt.
	6	Navy-yard and armory	125,000	125,000	Georgia	Quitman	Withcacoochee River	Suwanee River	H. E. Quinn.
	6	Navy-yard and armory	125,000	125,000	Georgia	Bainbridge	Flint River	Appalachicola River	H. E. Quinn.
	7	Navy-yard	340,000	340,000	Virginia	Charlottesville	Rivanna River	James River	G. C. Schuermann.
	9	Steamer Fish Hawk	387,000	387,000	Maryland	Havre de Grace	North East River	Susquehanna River	Z. L. Tanner.
	10	Armory	70,000	70,000	New York	Albany	Hudson River	Atlantic Ocean	W. F. Page.
	13	Armory and Fish Hawk	140,000	140,000	Virginia	Fredericksburg	Rappahannock River	Chesapeake Bay	G. H. H. Moore.
	15	Havre de Grace	30,000	30,000	Maryland	Battery Island	Susquehanna River	Chesapeake Bay	H. C. Chester.
	17	Battery Island	250,000	237,500	Maine	Waterville	Sebastacook River	Kennebec River	G. H. H. Moore.
	17	Battery Island	250,000	237,500	Maine	Mattawamkeag	Mattawamkeag River	Penobscot River	G. H. H. Moore.
			29,393,000	28,716,000					

TABLE VIII.—*Geographical record of distribution of young shad made under the direction of the United States Commissioner of Fish and Fisheries from April 26 to June 17, 1882.*

Date.	Where fish were hatched.	Number of fish—		Introduction of fish.				Transfer in charge of—
		Started with.	Actually planted.	State.	Town or place.	Stream.	Tributary of—	
1882.								
May 27	Navy-yard	250,000	250,000	Alabama	Selma	Alabama River	Mobile River	G. G. Davenport.
27	Navy-yard	300,000	300,000	Alabama	Troy	Conecuh River	Escanabia River	F. L. Donnelly.
27	Navy-yard	300,000	300,000	Alabama	Whiting	Escanabia Creek	Gulf of Mexico	F. L. Donnelly.
28	Navy-yard	240,000	216,000	Arkansas	Poplar Bluff	Black River	White River	G. H. H. Moore.
28	Navy-yard	248,000	216,000	Arkansas	Arkadelphia	Washita River	Red River	G. H. H. Moore.
June 1	Navy-yard and armory	891,000	891,000	Delaware	Seaford	Nanticoke River	Chesapeake Bay	J. F. Ellis.
April & May.	Navy-yard	3,050,000	3,050,000	Dist. of Columbia	Washington	Eastern Branch	Potomac River	W. M. Wood.
May 8	Navy-yard	250,000	231,000	Georgia	Newnan	Chattahoochie River	Appalachicola River	G. G. Davenport.
15	Navy-yard and armory	600,000	450,000	Georgia	Conyers	Oconee River	Altamaha River	H. E. Quinn.
15	Navy-yard and armory	600,000	450,000	Georgia	Covington	Yellow River	Ocmulgee River	H. E. Quinn.
21	Navy-yard	325,000	325,000	Georgia	Junction of Etowah and Oostenaula Rivers.	Coosa River	Mobile River	H. E. Quinn.
21	Navy-yard	350,000	350,000	Georgia	2 miles from Rome.	Etowah River	Coosa River	H. E. Quinn.
21	Navy-yard	325,000	325,000	Georgia	3 miles from Rome.	Oostenaula River	Coosa River	H. E. Quinn.
27	Navy-yard	200,000	200,000	Georgia	Atlanta	Chattahoochee River	Appalachicola River	F. L. Donnelly.
27	Navy-yard and armory	250,000	250,000	Georgia	West Point	Chattahoochee River	Appalachicola River	F. L. Donnelly.
June 6	Navy-yard and armory	125,000	125,000	Georgia	Quitman	Withlacooche River	Suwannee River	H. E. Quinn.
6	Navy-yard and armory	125,000	125,000	Georgia	Bainbridge	Flint River	Appalachicola River	H. E. Quinn.
3	Battery Island	150,000	145,000	Illinois	Danville	Big Vermillion River	Mississippi River	F. L. Donnelly.
3	Steamer Fish Hawk	150,000	145,000	Indiana	Covington	Wabash River	Ohio River	F. L. Donnelly.
3	Navy-yard and armory	958,000	958,000	Iowa	Dubuque	Mississippi River	Gulf of Mexico	J. F. Ellis.
2	Armory	75,000	74,000	Kansas	Ellsworth	Smoky Hill River	Kansas River	G. G. Davenport.
2	Armory	37,500	37,000	Kansas	New Cambria	Saline River	Smoky Hill River	D. B. Long.
2	Armory	37,500	37,000	Kansas	Solomon City	Solomon River	Kansas River	D. B. Long.
2	Armory	37,500	37,000	Kansas	Fort Riley	Republican River	Kansas River	D. B. Long.
2	Armory	37,500	37,000	Kansas	Manhattan	Big Blue River	Kansas River	D. B. Long.
May 18	Navy-yard	800,000	800,000	Kentucky	Towers	Kentucky River	Ohio River	N. Simmons.
18	Navy-yard and armory	800,000	800,000	Kentucky	Point Burnside	Cumberland River	Ohio River	N. Simmons.
31	Navy-yard	100,000	100,000	Kentucky	Shepherdsville	Salt River	Ohio River	H. E. Quinn.
31	Navy-yard	100,000	100,000	Kentucky	Munfordville	Green River	Ohio River	H. E. Quinn.
31	Navy-yard	100,000	100,000	Kentucky	Bowling Green	Barren River	Green River	H. E. Quinn.
June 17	Battery Island	250,000	237,500	Maine	Waterville	Sebastacoock River	Kennebec River	G. H. H. Moore.
17	Battery Island	250,000	237,500	Maine	Mattawamkeag	Mattawamkeag River	Penobscot River	G. H. H. Moore.
May 4	Navy-yard and armory	500,000	500,000	Maryland	Little Falls	Potomac River	Chesapeake Bay	N. Simmons.
5	Navy-yard and armory	430,000	430,000	Maryland	Little Falls	Potomac River	Chesapeake Bay	N. Simmons.
6	Armory	200,000	200,000	Maryland	Little Falls	Potomac River	Chesapeake Bay	Joseph Mace.
8	Navy-yard and armory	750,000	750,000	Maryland	Little Falls	Potomac River	Chesapeake Bay	Joseph Mace.

	13	Navy-yard	550, 000	550, 000	Maryland	Little Falls	Potomac River	Chesapeake Bay	G. G. Davenport.
	21	Armory	400, 000	400, 000	Maryland	Little Falls	Potomac River	Chesapeake Bay	Joseph Mace.
	25	Havre de Grace	400, 000	400, 000	Maryland	Battery Island	Susquehanna River	Chesapeake Bay	H. C. Chester.
	28	Navy-yard	300, 000	300, 000	Maryland	Little Falls	Potomac River	Chesapeake Bay	Joseph Mace.
	30	Navy-yard and armory	688, 000	688, 000	Maryland	Little Falls	Potomac River	Chesapeake Bay	Joseph Mace.
	31	Havre de Grace	1, 000, 000	1, 000, 000	Maryland	Battery Island	Susquehanna River	Chesapeake Bay	H. C. Chester.
	31	Steamer Fish Hawk	300, 000	300, 000	Maryland	Havre de Grace	North East River	Susquehanna River	Z. L. Tanner.
	1-31	Navy-yard	441, 000	441, 000	Maryland	Little Falls	Potomac River	Chesapeake Bay	Joseph Mace. (?)
June	1	Steamer Fish Hawk	200, 000	200, 000	Maryland	Havre de Grace	North East River	Susquehanna River	Z. L. Tanner.
	1	Havre de Grace	300, 000	300, 000	Maryland	Battery Island	Susquehanna River	Chesapeake Bay	H. C. Chester.
	2	Havre de Grace	150, 000	150, 000	Maryland	Battery Island	Susquehanna River	Chesapeake River	H. C. Chester.
	2	Steamer Fish Hawk	668, 000	668, 000	Maryland	Havre de Grace	North East River	Susquehanna River	Z. L. Tanner.
	5	Havre de Grace	75, 000	75, 000	Maryland	Battery Island	Susquehanna River	Chesapeake Bay	H. C. Chester.
	9	Steamer Fish Hawk	387, 000	387, 000	Maryland	Havre de Grace	North East River	Susquehanna River	Z. L. Tanner.
	15	Havre de Grace	30, 000	30, 000	Maryland	Battery Island	Susquehanna River	Chesapeake Bay	H. C. Chester.
May	20	Armory	24, 000	20, 000	New York	New York	East River	Atlantic Ocean	Balt. & Ohio Express.
	24	Navy-yard and armory	893, 000	893, 000	New York	Albany	Hudson River	Atlantic Ocean	N. Simmons.
June	10	Armory	70, 000	70, 000	New York	Albany	Hudson River	Atlantic Ocean	W. F. Page.
May	3	Navy-yard and armory	475, 000	450, 000	Ohio	Tiffin	Sandusky River	Ohio River	J. F. Ellis.
	22	Navy-yard and armory	300, 000	300, 000	Ohio	Zanesville	Muskingum River	Ohio River	G. H. H. Moore.
	22	Navy-yard and armory	545, 000	545, 000	Ohio	Columbus	Scioto River	Ohio River	G. H. H. Moore.
	22	Navy-yard and armory	300, 000	300, 000	Ohio	Athens	Hockhocking River	Ohio River	G. H. H. Moore.
	12	Navy-yard	250, 000	248, 000	South Carolina	C. & A. A. L. Crossing.	Broad River	Santee River	C. J. Huske.
	17	Navy-yard	250, 000	249, 000	South Carolina	C. & A. A. L. Crossing.	Broad River	Santee River	C. J. Huske.
	19	Armory	400, 000	400, 000	Tennessee	Chattanooga	Tennessee River	Ohio River	G. G. Davenport.
	11	Navy-yard and armory	1, 000, 000	870, 000	Texas	Austin	Colorado River	Gulf of Mexico	J. F. Ellis.
	28	Navy-yard	370, 000	306, 000	Texas	Jefferson	Big Cypress Creek	Caddo Lake	G. H. H. Moore.
	28	Navy-yard	370, 000	342, 000	Texas	Fort Worth	Trinity River	Trinity Bay	G. H. H. Moore.
April	26	Steamer Fish Hawk	20, 000	20, 000	Virginia	Quantico	Quantico Creek	Potomac River	Z. L. Tanner.
May	3	Steamer Fish Hawk	30, 000	30, 000	Virginia	Quantico	Quantico Creek	Potomac River	Z. L. Tanner.
	4	Steamer Fish Hawk	20, 000	20, 000	Virginia	Quantico	Quantico Creek	Potomac River	Z. L. Tanner.
	7	Steamer Fish Hawk	40, 000	40, 000	Virginia	Quantico	Quantico Creek	Potomac River	Z. L. Tanner.
May	8	Steamer Fish Hawk	177, 000	177, 000	Virginia	Quantico	Quantico Creek	Potomac River	Z. L. Tanner.
	9	Navy-yard	300, 000	300, 000	Virginia	Va. Midland R. R. Crossing.	Rappahannock River	Chesapeake Bay	G. C. Schuermann.
	9	Steamer Fish Hawk	415, 000	415, 000	Virginia	Quantico	Quantico Creek	Potomac River	Z. L. Tanner.
	10	Steamer Fish Hawk	125, 000	125, 000	Virginia	Quantico	Quantico Creek	Potomac River	Z. L. Tanner.
	11	Steamer Fish Hawk	845, 000	845, 000	Virginia	Quantico	Quantico Creek	Potomac River	Z. L. Tanner.
	12	Steamer Fish Hawk	63, 000	63, 000	Virginia	Quantico	Quantico Creek	Potomac River	Z. L. Tanner.
	12	Armory	300, 000	300, 000	Virginia	Farmville	Appomattox River	James River	F. L. Donnelly.
	13	Navy-yard and armory	470, 000	470, 000	Virginia	Fredericksburg	Rappahannock River	Chesapeake Bay	G. C. Schuermann.
	13	Navy-yard	300, 000	300, 000	Virginia	Strasburgh	Shenandoah River	Potomac River	H. E. Quinn.
	22	Steamer Fish Hawk	20, 000	20, 000	Virginia	Quantico	Quantico Creek	Potomac River	Z. L. Tanner.
June	7	Navy-yard	340, 000	340, 000	Virginia	Charlottesville	Rivanna River	James River	G. C. Schuermann.
	13	Armory and Fish Hawk	140, 000	140, 000	Virginia	Fredericksburg	Rappahannock River	Chesapeake Bay	G. H. H. Moore.
May	7	Armory	250, 000	240, 000	West Virginia	Wheeling	Ohio River	Mississippi River	N. Simmons.
June	5	Navy-yard and armory	210, 000	210, 000	West Virginia	Piedmont	Potomac River	Chesapeake Bay	W. D. Wirt.
			29, 393, 000	28, 716, 000					

XXXVIII.—REPORT ON THE DISTRIBUTION OF CARP DURING THE SEASON OF 1882.

By Marshall McDonald.

In the inception of the work of carp distribution in 1879 the shipments were always in charge of messengers, who gave assiduous attention to the aeration and frequent change of water *en route*, accompanied the fish to their destination, and delivered them to the applicants or their authorized agents. The vessels employed in transportation were tin cans, having a capacity of from 10 to 15 gallons each. The number of cans taken in one shipment was usually twelve; namely, ten cans for fish and two for water. At first the number of fish to the can was limited to fifty, thus making a messenger shipment to consist of five hundred fish.

As the robust vigor and vitality of the carp came to be better understood and appreciated the number of fish permitted to a can was gradually increased, so that in the latter part of the distribution of 1881 single shipments of twelve and fifteen hundred fish were made by messenger to distances 900 miles from Washington.

With the increasing number distributed each year it was found impracticable to make the entire distribution by messenger service, both on account of the cost attending the same and the large force of experienced men it was necessary to keep in the field. Arrangements were therefore made to ship by express, special rates being arranged with the express companies. To an applicant receiving the usual allotment of twenty fish the cost of shipping packages weighing 100 pounds or more was very exorbitant, the rates ranging from 75 cents, to points near Washington, to $10, $12, and even $15, to parties in more remote localities. To reduce this cost half cans, weighing proportionately less, were, by direction of the United States Commissioner of Fisheries, substituted for the ordinary 10-gallon transportation cans first employed. Meanwhile experiments were instituted for the purpose of determining the minimum volume of water and the minimum weight of vessel that might be employed for safe distribution of carp by express.

The results of these experiments, detailed in full in United States Fish Commission Bulletin, volume 1, page 215, showed that we might use tin cans having a capacity of 1 gallon for distribution to points distant in time from twenty-four to forty-eight hours from place of distribution. The experience of 1881 also showed that by the use of a transportation car, with refrigerator compartments, so as to enable us to control and keep down the temperature to 55° or 60° in the interior,

we could hold the fish in these small vessels for weeks with occasional changes of water, and then forward them by express several hundred miles. This method was applied in the trans-Mississippi distribution, made in the latter part of 1881, with the most gratifying results, nearly twenty thousand fish having been transported from Washington, and distributed to applicants in all parts of Texas, West Louisiana, Indian Territory, and Arkansas. In making the distribution of 1882 it was determined to put in full operation the new methods and apparatus of distribution. Meanwhile an additional refrigerator car, constructed according to the plans of Mr. Frank S. Eastman, was completed and ready for service. Car No. 1 was also remodeled to conform essentially to the new design.

The opening of the season of 1882 found us prepared with two cars complete in all respects for distribution.

The following programme of the organization and conduct of this work was therefore submitted, and being approved by the United States Commissioner of Fisheries, was carried out in all its essential details in the distribution of 1882.

1. GENERAL PLAN OF THE DISTRIBUTION.

It is proposed that the distribution be made—

(*a*) By express, from Washington direct to destination, where the distance in time is not more than twenty-four or thirty-six hours, the shipping package being the ordinary 4-quart tin pail, the cost of which will be included in the express charges, and the pail kept by consignee. The cost of pails will be collected from the central express office at Washington.

(*b*) For points in States too remote from Washington to be reached by express shipments direct, or where the cost of express shipment entails a disproportionate charge on consignee, it is proposed to send our cars to central points of distribution in different sections of the country, the points being selected with reference to their facilities for distribution by express, and from these points to distribute by express in the same manner as indicated for express shipments from Washington; for this purpose a distributing agent will be left at such points to complete the work of distribution, the car returning to Washington for a new supply as soon as its load is safely deposited at destination and arrangements made to care for the fish until distributed.

The agent having completed the distribution at one point will be transferred to another, to meet another consignment, the movements of cars and distributing agents being so timed or regulated by telegraph that there will be no confusion, but all the distribution will proceed in a systematic and orderly manner.

It is proposed that the United States Commission in all cases bear the costs of transportation to the centers of distribution fixed upon, charges from these points to destination, and the cost of pail (to be included in express charges) to be paid by consignee. The entire cost to

applicants will range from 40 cents to 75 cents; in no case, probably, will it exceed $1.

(*c*) Individual messenger shipments only to be resorted to in cases of imminent emergency. Such shipments are not usually satisfactory, and the cost of distribution in proportion to work accomplished is much greater for the Commission than in the methods (*a*) and (*b*).

2. PERSONNEL OF THE WORK.

For each car, one messenger in charge, two messenger assistants, one cook, and for the field work of distribution one or more distributing agents, as above indicated.

At central station, there will be needed in addition to the permanent force of the station, one good man to assist in making the shipments and to care for the carp awaiting distribution.

Each messenger in charge of cars will be charged with all property issued for the equipment or service of his car, and will be responsible for the same, so long as it remains in his possession, and will not be discharged from such liability until the same is returned to the central station and proper receipts obtained from store-keeper.

In addition to a property record he will be required to keep an account of all expenditures made: (1.) For the subsistence of himself and men; (2.) For all other expenses; (3.) The number of miles traveled, and required to report the same from time to time, the several reports covering the whole period of continuous service; the object being to show the cost per diem per man for subsistence and the miscellaneous expenses of the maintenance of car per mile traveled.

3. ORDER OF DISTRIBUTION.

It is proposed that the distribution begin first in the New England and extreme Northwestern States, the theater of operations being shifted farther and farther to the South as winter approaches, the last work being done in the South Atlantic and Gulf States.

4. PRELIMINARIES TO DISTRIBUTION.

(*a*) Shipping-tag made of stout manilla paper, in the form of jacket and containing the return postal receipt. On the tag will be printed the instructions to be observed in transportation, one side being reserved for this, the other for the shipping address. Samples of these and the circulars for express work I have requested Mr. S. C. Brown to prepare and have ready to submit to you.

(*b*) In all cases where an application is on file in this office, or where distribution is to be made, or lists furnished by State commissioners, it will be necessary, several days prior to sending the fish, to mail a circular giving due notice of the time and manner of shipment, so that consignees may have due notice to prepare for and receive their fish.

Form marked M provides for this notice, whether delivery is made by messenger or through State commission. This, in conjunction with form N, to be sent to consignee by messenger or agent, provides for all cases.

In accordance with the programme Mr. George H. H. Moore was placed in charge of car No. 1, and Mr. J. F. Ellis in charge of car No. 2, Mr. George G. Davenport being designated as distributing agent.

The ponds having been drawn, the distribution was inaugurated by a car shipment to Boston, in which distribution provision was made for all applicants in the New England States, New York, and the northern half of New Jersey. From this time until about the 1st of February, when the distribution terminated, the cars were in continuous service.

In order to complete the work in the time fixed, it was necessary to open a depot of distribution at Atlanta for the supply of the South Atlantic and Gulf States. Mr. Davenport was ordered to this point, and having organized the station remained in charge until the completion of the work, the fish being forwarded to him from Washington.

The following is a summary showing the points of distribution in each State, the date, and the messenger in charge.

Distribution of German carp in the United States for the year 1882–'83.

State.	Point of distribution.	Messenger.	Date.
Alabama	Montgomery, Ala	J. F. Ellis	Dec. 17, 1882.
Arizona Territory	Tucson, Ariz	G. H. H. Moore	Jan. 23, 1883.
Arkansas	Saint Louis, Mo	J. F. Ellis	Nov. 13, 1882.
California	San Francisco, Cal	G. H. H. Moore	Jan. 23, 1883.
Colorado	Denver, Colo	D. B. Long, commissioner, Kansas	Nov. 10, 1882.
Connecticut	Boston, Mass	G. H. H. Moore	Nov. 4, 1882.
Dakota Territory	Saint Paul, Minn	G. H. H. Moore	Nov. 10, 1882.
Delaware	Washington, by express	Express Company	Jan. 1, 1883.
District of Columbia	Washington	Individual orders	Nov. 1, 1882.
Florida	Jacksonville, Fla	J. F. Ellis	Dec. 9, 1882.
Georgia	Atlanta, Ga	G. G. Davenport	Dec. 9, 1882.
Idaho Territory	Saint Paul, Minn	G. H. H. Moore	Jan. 23, 1883.
Illinois	Quincy, Ill	G. H. H. Moore	Nov. 10, 1882.
Indiana	Indianapolis, Ind	J. F. Ellis	Nov. 23, 1882.
Indian Territory	Sherman, Tex	J. F. Ellis	Jan. 17, 1883.
Iowa	Des Moines, Iowa	G. H. H. Moore	Nov. 10, 1882.
Kansas	Ellsworth, Kans	D. B. Long, commissioner	Nov. 10, 1882.
Kentucky	Louisville, Ky	J. F. Ellis	Nov. 7, 1882.
Louisiana	New Orleans, La	J. F. Ellis	Dec. 9, 1882.
Maine	Boston, Mass	G. H. H. Moore	Nov. 4, 1882.
Maryland	Washington	Express company	Nov. 1, 1882.
Massachusetts	Boston, Mass	G. H. H. Moore	Nov. 4, 1882.
Michigan	Toledo, Ohio	G. H. H. Moore	Nov. 21, 1882.
Minnesota	Saint Paul, Minn	G. H. H. Moore	Nov. 10, 1882.
Mississippi	Jackson, Miss	J. F. Ellis	Dec. 9, 1882.
Missouri	Saint Louis, Mo	J. F. Ellis	Nov. 13, 1882.
Montana Territory	Unsupplied	Unsupplied	Unsupplied.
Nebraska	Des Moines, Iowa	G. H. H. Moore	Nov. 10, 1882.
Nevada	Portland, Oreg	G. H. H. Moore	Jan. 24, 1883.
New Hampshire	Boston, Mass	G. H. H. Moore	Nov. 4, 1882.
New Jersey	Washington	Express company	Nov. 1, 1882.
Do	Philadelphia, Pa	M. P. Pierce	Nov. 1, 1882.
Do	New York City	E. G. Blackford	Nov. 1, 1882.
New Mexico Ter	Deming, N. Mex	G. H. H. Moore	Jan. 23, 1883.
New York	New York City	E. G. Blackford	Nov. 4, 1882.
North Carolina	Raleigh, N. C	S. G. Worth, superintendent	Dec. 5, 1882.
Ohio	Columbus, Ohio	G. H. H. Moore	Nov. 21, 1882.
Oregon	Portland, Oreg	G. H. H. Moore	Jan. 23, 1883.
Pennsylvania	Washington	Express company	Nov. 1, 1882.
Rhode Island	Boston, Mass	G. H. H. Moore	Nov. 4, 1882.
South Carolina	Columbia, S. C	C. J. Huske, superintendent	Dec. 6, 1882.
Tennessee	Nashville, Tenn	J. F. Ellis	Dec. 17, 1882.
Texas	Dallas and other points	J. F. Ellis	Jan. 11, 1882.
Utah Territory	Ogden, Utah	G. H. H. Moore	Jan. 23, 1883.
Vermont	Boston, Mass	G. H. H. Moore	Nov. 4, 1882.
Virginia	Washington	Express company	Nov. 1, 1882.
Do	Richmond, Va	William F. Page	Nov. 1, 1882.
Washington Ter	Portland, Oreg	G. H. H. Moore	Jan. 23, 1883.
West Virginia	Washington	Express company	Nov. 1, 1882.
Wisconsin	Saint Paul, Minn	G. H. H. Moore	Nov. 10, 1882.
Wyoming Territory	Ogden, Utah	G. H. H. Moore	Jan. 23, 1883.

Complete details of the distribution arranged by States, Congressional districts, and counties is appended to this report. This distribution reached applicants in every State and Territory in the United States, except Montana. Fish were sent into 298 of the 301 Congressional districts and into 1,478 counties. The total number of applicants supplied was 9,872, and the total number of fish distributed 259,000; the average distance of applicant being 916 miles from Washington. The total mileage, counting all as single shipments from Washington to destination was 9,045,000 miles. The cars during the season traversed a total distance of 34,502 miles, of which car No. 1 traveled 20,601, and car No. 2 13,901 miles.

SUMMARY OF CARP DISTRIBUTED IN THE UNITED STATES AND FOREIGN COUNTRIES FOR THE YEAR 1882.

States, &c.	Number of Congressional districts.	Number of counties.	Number of applicants.	Number of fish.
Alabama	8	54	275	5,538
Arizona Territory	....	5	8	201
Arkansas	4	22	73	1,632
California	4	29	79	2,431
Colorado	....	12	36	720
Connecticut	4	8	59	1,245
Dakota Territory	....	11	17	340
Delaware	....	3	8	160
District of Columbia	....	....	27	540
Florida	2	14	35	720
Georgia	9	116	1,059	22,768
Idaho Territory	....	2	2	40
Illinois	19	75	340	12,047
Indiana	13	73	368	12,726
Indian Territory	....	3	6	120
Iowa	9	54	121	3,543
Kansas	3	66	222	4,710
Kentucky	10	84	942	30,743
Louisiana	6	20	66	1,382
Maine	5	6	8	535
Maryland	6	21	103	4,219
Massachusetts	11	13	58	1,245
Michigan	9	22	43	970
Minnesota	3	24	49	6,092
Mississippi	6	53	509	10,206
Missouri	13	58	285	15,031
Nebraska	....	19	26	564
Nevada	....	7	9	190
New Hampshire	3	7	15	357
New Jersey	5	18	100	4,018
New Mexico Territory	....	6	9	180
New York	33	40	233	7,209
North Carolina	8	80	1,202	25,547
Ohio	20	72	418	11,752
Oregon	....	17	48	960
Pennsylvania	27	60	503	12,808
Rhode Island	1	3	7	140
South Carolina	5	29	500	10,331
Tennessee	10	50	251	6,300
Texas	6	83	860	18,982
Utah Territory	....	9	18	360
Vermont	3	4	7	140
Virginia	9	64	688	15,597
Washington Territory	....	10	25	500
West Virginia	3	29	116	2,503
Wisconsin	8	20	31	621
Wyoming Territory	....	3	4	80
Foreign countries	....	....	4	145
Total	298	1,478	9,872	259,188

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1882—Continued.

ALABAMA.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
THE STATE.			
1	5	9	180
2	7	56	1,120
3	7	79	1,580
4	4	40	800
5	9	20	400
6	3	15	300
7	12	35	718
8	7	21	440
Total	54	275	5,538

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Choctaw	2	40
	Clarke	2	40
	Marengo	3	60
	Mobile	1	20
	Monroe	1	20
2	Baldwin	2	40
	Butler	21	420
	Conecuh	1	20
	Covington	5	100
	Crenshaw	10	200
	Escambia	1	20
	Montgomery	16	320
3	Barbour	21	420
	Bullock	26	520
	Dale	2	40
	Geneva	2	40
	Henry	8	160
3—Cont'd	Lee	9	180
	Russell	11	220
4	Dallas	27	540
	Hale	7	140
	Lowndes	1	20
	Perry	5	100
5	Autauga	2	40
	Bibb	1	20
	Chambers	2	40
	Chilton	1	20
	Clay	1	20
	Coosa	2	40
	Elmore	2	40
	Macon	3	60
	Tallapoosa	6	120
6	Jefferson	3	60
	Pickens	5	100
	Sumter	7	140
7	Blount	5	118
	Calhoun	7	140
	Cherokee	1	20
	Cleburne	2	40
	De Kalb	1	20
	Etowah	2	40
	Marshall	1	20
	Randolph	4	80
	Saint Clair	1	20
	Shelby	1	20
	Talladega	8	160
	Tuscaloosa	2	40
8	Colbert	1	20
	Franklin	2	40
	Jackson	1	40
	Lauderdale	3	60
	Lawrence	5	100
	Limestone	2	40
	Madison	7	140
Total		275	5,538

ARIZONA.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
At large	5	8	201
Total	5	8	201
Number of fish shipped to the State commissioner for distribution unaccounted for			797
Grand total			998

Congressional districts.	Counties.	No. of applicants.	No. of fish.
At large	Cochise	3	101
	Maricopa	0	0
	Pima	2	40
	Yavapai	2	40
	Yuma	1	20
Total		8	201

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1882—Continued.

ARKANSAS.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
THE STATE.			
1	5	8	160
2	11	43	1, 012
3	3	7	160
4	3	15	300
Total	22	73	1, 632

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Arkansas	1	20
	Lee	1	20
	Mississippi	1	20
1—Cont'd	Phillips	4	80
	Saint Francis	1	20
2	Clark	3	60
	Columbia	2	40
	Dorsey	1	20
	Hempstead	12	272
	Hot Springs	3	120
	Jefferson	3	80
	Miller	4	80
	Nevada	1	20
	Ouachita	1	20
	Sevier	5	100
	Union	8	200
3	Garland	3	60
	Montgomery	1	20
	Pulaski	3	80
4	Benton	11	220
	Carroll	1	20
	Washington	3	60
Total		73	1, 632

CALIFORNIA.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
THE STATE.			
1	1	8	160
2	7	29	601
3	10	13	260
4	11	29	610
Total	29	79	1, 631
Number of fish shipped to the State commissioner for distribution unaccounted for			800
Grand total			2, 431

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	San Francisco	8	160
2	Alameda	15	321
	Calaveras	2	40
2—Cont'd	Contra Costa	5	100
	Nevada	1	20
	Placer	3	60
	San Joaquin	2	40
	Tuolumne	1	20
3	Lassen	1	20
	Mendocino	1	20
	Modoc	1	20
	Napa	1	20
	Plumas	1	20
	Shasta	3	60
	Solano	1	20
	Sonoma	2	40
	Sutter	1	20
	Yuba	1	20
4	Kern	1	50
	Inyo	1	20
	Los Angeles	3	60
	Merced	9	180
	San Bernardino	1	20
	San Diego	1	20
	San Mateo	1	20
	Santa Clara	4	80
	Santa Cruz	2	40
	Stanislaus	4	80
	Tulaire	2	40
Total		79	1, 631

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1882—Continued.

COLORADO.

Congressional district.	Counties.	No. of applicants.	No. of fish.	Congressional district.	Counties.	No. of applicants.	No. of fish.
At large	Bent	3	60	At large—C'd.	La Plata	2	40
	Arapahoe	6	120		Larimer	6	120
	Boulder	4	80		Las Animas	2	40
	Conejos	1	20		Pueblo	1	20
	El Paso	3	60		Weld	2	40
	Fremont	5	100				
	Huerfano	1	20	Total		36	720

CONNECTICUT.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.	Congressional districts.	Counties.	No. of applicants.	No. of fish.
THE STATE.				1	Hartford	16	321
1	2	19	381		Tolland	3	60
2	2	19	424	2	Middlesex	4	80
3	2	9	180		New Haven	15	344
4	2	12	260	3	New London	5	100
					Windham	4	80
Total	8	59	1,245	4	Fairfield	8	180
					Litchfield	4	80
				Total		59	1,245

DAKOTA.

Congressional district.	Counties.	No. of applicants.	No. of fish.	Congressional district.	Counties.	No. of applicants.	No. of fish.
At large	Barnes	1	20	At large—C'd.	Richland	1	20
	Custer	2	40		Shannon	1	20
	Grand Forks	1	20		Union	1	20
	Kingsbury	2	40		Yankton	1	20
	Lake	1	20				
	Lawrence	4	80	Total		17	340
	Pennington	2	40				

DELAWARE.

Congressional district.	Counties.	Number of applicants.	Number of fish.
At large	Kent	4	80
	New Castle	3	60
	Sussex	1	20
Total		8	160

DISTRICT OF COLUMBIA.

Number of applicants	27
Number of fish	540

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1882—Continued.

FLORIDA.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
THE STATE.			
1	4	9	200
2	10	26	520
Total	14	35	720

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Escambia	2	60
	Gadsden	2	40
1—Cont'd	Hernando	1	20
	Sumter	4	80
2	Alchua	2	40
	Columbia	1	20
	Duval	1	20
	Madison	1	20
	Marion	1	20
	Orange	6	120
	Putnam	9	180
	Saint John's	1	20
	Suwanne	2	40
	Volusia	2	40
Total		35	720

GEORGIA.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
THE STATE.			
1	13	44	901
2	13	83	1,707
3	13	68	1,448
4	12	149	2,955
5	11	115	2,369
6	12	137	3,082
7	13	152	3,207
8	15	202	4,103
9	13	108	2,216
Not given	1	1	20
Total	116	1,059	22,008
Number of fish shipped to the State commissioner and agents for distribution unaccounted for			760
Grand total			22,768

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Appling	1	20
	Bryan	2	40
	Bullock	3	60
	Burke	7	160
	Camden	1	20
	Clinch	2	40
	Echols	2	40
	Emanuel	1	21
	Liberty	9	180
	Scriven	5	100
	Tatnall	1	20
	Ware	6	120
	Wayne	4	80
2	Berrien	1	20
	Brooks	31	640
	Calhoun	1	20
	Clay	7	140
	Decatur	3	60
	Dougherty	2	60
	Early	2	40
	Lowndes	4	80
	Quitman	2	40
	Randolph	6	120
	Terrell	1	20
	Thomas	15	300
	Worth	8	167
3	Coffee	2	40
	Dodge	1	20
	Dooly	3	60
	Lee	1	20
	Macon	3	60
	Pulaski	6	188
	Schley	1	20
	Stewart	9	180
	Sumter	15	320
	Taylor	7	140
	Telfair	7	140
	Webster	4	80
	Wilcox	9	180
4	Campbell	26	520
	Carroll	14	280
	Chattahoochee	4	95
	Coweta	24	480
	Douglas	7	140
	Harris	20	400
	Heard	4	80
	Marion	4	80
	Meriwether	12	240
	Muscogee	8	160
	Talbot	14	300
	Troup	12	180
5	Clayton	6	120
	Crawford	1	20
	De Kalb	12	240
	Fayette	7	140
	Fulton	30	600

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1882—Continued.

GEORGIA—Continued.

Congressional districts.	Counties.	No. of applications.	No. of fish.	Congressional districts.	Counties.	No. of applications.	No. of fish.
5—Cont'd	Henry	10	200	8—Cont'd	Elbert	18	361
	Houston	4	80		Glascock	4	80
	Milton	6	140		Green	9	194
	Pike	9	200		Hancock	19	380
	Spalding	20	410		Hart	49	1,020
	Upson	10	219		Jefferson	10	200
6	Baldwin	19	381		McDuffie	5	100
	Bibb	4	80		Madison	7	140
	Butts	2	40		Oglethorpe	9	180
	Jasper	1	20		Richmond	14	280
	Jones	1	20		Taliaferro	8	160
	Laurens	2	40		Warren	15	300
	Newton	23	777		Washington	16	323
	Putnam	8	160		Wilkes	13	265
	Rockdale	50	1,024	9	Banks	9	220
	Twiggs	3	60		Clarke	14	280
	Walton	22	440		Forsyth	7	140
	Wilkinson	2	40		Franklin	7	140
7	Bartow	9	180		Gwinnett	15	300
	Catoosa	11	290		Habersham	23	464
	Chattooga	4	81		Hall	7	140
	Cherokee	17	360		Jackson	15	312
	Cobb	25	520		Morgan	1	20
	Dade	14	300		Pickens	2	40
	Floyd	19	385		Rabun	3	60
	Gordon	7	150		Union	4	80
	Murray	3	60		White	1	20
	Paulding	6	120	Not given	Oconee	1	20
	Polk	12	250				
	Walker	11	220		Total	1,059	22,008
	Whitfield	14	291				
8	Columbia	6	120				

IDAHO.

Congressional district.	County.	Number of applicants.	Number of fish.
At large	Bear Lake	1	20
	Oneida	1	20
Total		2	40

ILLINOIS.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.	Congressional districts,	No. of counties.	No. of applications.	No. of fish.
THE STATE.				THE STATE—Continued.			
2	1	10	208	16	6	26	560
3	1	2	60	17	4	29	630
4	3	20	400	18	6	21	440
5	2	4	80	19	9	19	380
6	3	7	140	Not given	1	1	20
7	3	5	100				
8	3	7	140	Total	75	340	7,007
9	3	12	240				
10	4	22	440				
11	5	83	1,680	Number of fish shipped to the State commissioner for distribution unaccounted for			5,040
12	3	29	580				
13	4	6	140				
14	6	15	329				
15	8	22	440	Grand total			12,047

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1882—Continued.

ILLINOIS—Continued.

Congressional districts.	Counties.	No. of applicants.	No. of fish.	Congressional districts.	Counties.	No. of applicants.	No. of fish.
2	Cook	10	208	14—Cont'd	Macon	2	40
3	Lake	2	60		Piatt	1	20
4	De Kalb	6	120		Vermillion	4	89
	Kane	11	220	15	Clark	1	20
	McHenry	3	60		Crawford	1	20
5	Ogle	2	40		Cumberland	7	140
	Stephenson	2	40		Edgar	1	20
6	Bureau	2	40		Effingham	3	60
	Henry	2	40		Fayette	1	20
	Lee	3	60		Jasper	3	60
7	Kendall	2	40		Lawrence	5	100
	La Salle	1	20	16	Bond	2	40
	Will	2	40		Clay	3	60
8	Iroquois	3	60		Clinton	4	80
	Kankakee	2	40		Marion	8	200
	Woodford	2	40		Montgomery	8	160
9	Knox	6	120		Washington	1	20
	Peoria	5	100	17	Macoupin	7	160
	Stark	1	20		Madison	10	200
					Monroe	1	50
10	Hancock	16	320		Saint Clair	11	220
	McDonough	2	40	18	Jackson	2	40
	Mercer	2	40		Johnson	1	20
	Warren	2	40		Massac	2	40
11	Adams	71	1,420		Perry	3	60
	Brown	3	80		Randolph	12	260
	Green	5	100		Union	1	20
	Jersey	1	20	19	Edwards	2	40
	Pike	3	60		Franklin	3	60
12	Cass	2	40		Gallatin	3	60
	Morgan	14	280		Hamilton	2	40
	Sangamon	13	260		Jefferson	1	20
13	De Witt	1	20		Richland	2	40
	Logan	1	20		Saline	2	40
	Mason	1	20		Wabash	1	20
	Tazewell	3	80		White	3	60
14	Champaign	2	60	Not given	Du Page	1	20
	Coles	4	80				
	Douglas	2	40			340	7,007

INDIANA.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
THE STATE.			
1	5	18	380
2	8	35	713
3	5	34	684
4	7	46	931
5	8	50	1,004
6	6	53	1,060
7	3	23	465
8	5	19	385
9	5	9	196
10	6	33	700
11	7	19	387
12	5	14	281
13	3	15	340
Total	73	368	7,526
Number of fish shipped to the State commissioner for distribution unaccounted for			5,200
Grand total			12,726

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Gibson	1	20
	Pike	1	20
	Spencer	10	220
	Vanderburgh	5	100
	Warrick	1	20
2	Daviess	2	40
	Dubois	1	20
	Green	2	45
	Knox	14	300
	Lawrence	2	40
	Martin	3	60
	Orange	2	40
	Sullivan	9	168
3	Clark	3	60
	Floyd	7	140
	Harrison	6	120
	Jennings	8	160
	Washington	10	204
4	Dearborn	8	160
	Decatur	6	120
	Franklin	4	80
	Jefferson	5	100

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1882—Continued.

INDIANA—Continued.

Congressional districts.	Counties.	No. of applicants.	No. of fish.	Congressional districts.	Counties.	No. of applicants.	No. of fish.
4—Cont'd	Ohio	1	23	9—Cont'd	Hamilton	1	40
	Ripley	14	80		Madison	2	20
	Switzerland	5	200		Tippecanoe	4	96
	Union	3	168		Tipton	1	20
5	Bartholomew	1	20	10	Carroll	16	320
	Brown	1	20		Cass	2	40
	Hendricks	9	180		Lake	8	200
	Johnson	6	124		Newton	1	20
	Monroe	6	120		Porter	5	100
	Morgan	5	100		White	1	20
	Owen	14	280	11	Grant	2	42
	Putnam	8	160		Howard	4	84
6	Delaware	1	20		Huntington	2	40
	Fayette	16	320		Jay	5	100
	Henry	6	120		Miami	1	20
	Randolph	2	40		Wabash	4	80
	Rush	8	160		Wells	1	21
	Wayne	20	400	12	Allen	3	61
7	Hancock	1	25		De Kalb	1	20
	Marion	18	360		Lagrange	3	60
	Shelby	4	80		Noble	3	60
8	Clay	6	120		Steuben	4	80
	Montgomery	5	105	13	Kosciusko	8	200
	Park	3	60		La Porte	4	80
	Vermillion	4	80		Saint Joseph	3	60
	Vigo	1	20				
9	Clinton	1	20	Total		368	7,526

INDIAN TERRITORY.

Congressional district.	Counties.	Number of applicants.	Number of fish.
At large	Cherokee	3	60
	Chickasaw	2	40
	Choctaw	1	20
Total		6	120

IOWA.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
THE STATE.			
1	6	19	402
2	5	10	232
3	5	11	220
4	3	5	100
5	6	13	260
6	6	12	260
7	7	17	340
8	6	15	319
9	10	19	410
Total	54	121	2,543
Number of fish shipped to the State commissioner and agents for distribution unaccounted for			1,000
Grand total			3,543

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Henry	7	154
	Jefferson	3	68
	Lee	5	100
	Louisa	1	20
	Van Buren	1	20
	Washington	2	40
2	Clinton	2	40
	Jackson	1	20
	Jones	3	72
	Muscatine	3	60
	Scott	1	40
3	Allamakee	3	60
	Clayton	1	20
	Dubuque	3	60
	Fayette	1	20
	Winneshiek	3	60
4	Black Hawk	1	20
	Floyd	2	40
	Winnebago	2	40

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1882—Continued.

IOWA—Continued.

Congressional districts.	Counties.	No. of applicants.	No. of fish.
5	Benton	3	60
	Iowa	2	40
	Johnson	3	60
	Linn	3	60
	Marshall	1	20
	Poweshiek	1	20
6	Appanoose	1	20
	Davis	2	40
	Mahaska	1	20
	Marion	2	40
	Monroe	1	20
	Wapello	5	120
7	Clarke	1	20
	Dallas	1	20
	Decatur	1	20
	Lucas	8	160
	Polk	4	80
	Warren	1	20
	Wayne	1	20

Congressional districts.	Counties.	No. of applicants.	No. of fish.
8	Adams	2	40
	Cass	3	60
	Page	2	47
	Ringgold	4	80
	Shelby	1	82
	Taylor	3	60
9	Carroll	2	40
	Cherokee	2	40
	Dickinson	1	40
	Greene	1	20
	Hamilton	1	20
	Lyon	1	20
	Palo Alto	2	40
	Plymouth	1	20
	Story	6	120
	Webster	2	50
Total		121	2,543

KANSAS.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
THE STATE.			
1	23	84	1,783
2	13	65	1,391
3	19	49	1,046
Not given	11	24	490
Total	66	222	4,710

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Clay	3	60
	Cloud	2	40
	Davis	5	103
	Dickinson	7	200
	Doniphan	10	220
	Ellsworth	8	160
	Ellis	4	80
	Jackson	2	40
	Jewell	1	20
	Leavenworth	6	120
	Lincoln	1	20
	Marshall	3	60
	Mitchell	2	40
	Nemaha	5	100
	Ottawa	2	40
	Phillips	2	40
	Pottawatomie	6	140
	Republic	1	20
	Riley	4	80
	Russell	4	80
	Saline	1	20
	Smith	1	20
	Washington	4	80
2	Allen	2	40
	Anderson	10	221
	Bourbon	7	140

Congressional districts.	Counties.	No. of applicants.	No. of fish.
2—Cont'd	Crawford	4	80
	Douglas	3	60
	Franklin	11	220
	Johnson	4	80
	Labette	8	200
	Linn	2	40
	Miami	4	80
	Montgomery	1	20
	Neosho	6	150
	Wyandotte	3	60
3	Barbour	5	105
	Butler	2	40
	Chase	2	40
	Coffey	3	61
	Cowley	1	20
	Ford	2	60
	Harvey	1	20
	Greenwood	2	40
	McPherson	1	20
	Lyon	4	100
	Osage	4	80
	Pawnee	1	20
	Rice	2	40
	Reno	6	120
	Sedgwick	1	20
	Shawnee	5	120
	Sumner	3	60
	Wabaunsee	1	20
	Woodson	3	60
Not given	Gove	1	20
	Graham	2	40
	Kearney	2	40
	Harper	6	120
	Kingman	3	60
	Ness	1	20
	Pratt	2	50
	Salem	1	20
	Sequoyah	3	60
	Trego	1	20
	Wallace	2	40
Total		222	4,710

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1882—Continued.

KENTUCKY.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
THE STATE:			
1	9	46	939
2	8	95	1,958
3	10	236	5,066
4	11	76	1,904
5	2	63	1,295
6	8	44	946
7	10	214	4,435
8	9	112	2,434
9	7	32	850
10	10	24	496
Total	84	942	20,323
Number of fish shipped to the State commissioner and agents for distribution unaccounted for			10,420
Grand total			30,743

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Ballard	9	180
	Caldwell	9	180
	Fulton	2	40
	Graves	18	360
	Hickman	2	49
	Lyon	1	20
	McCracken	3	60
	Marshall	1	20
	Trigg	1	30
2	Christian	17	340
	Daviess	43	860
	Hancock	2	40
	Henderson	13	303
	Hopkins	1	20
	Muhlenburg	1	20
	Ohio	2	50
	Union	16	325
3	Barren	79	1,600
	Butler	1	20
	Cumberland	4	80
	Edmonson	2	40
	Logan	57	1,186
	Metcalf	2	40
	Monroe	2	40
	Simpson	10	220
	Todd	44	900
	Warren	35	940
4	Breckinridge	4	80
4—Cont'd	Grayson	1	20
	Green	1	20
	Hardin	23	460
	Hart	20	589
	La Rue	1	100
	Marion	5	175
	Meade	4	80
	Nelson	9	180
	Spencer	6	160
	Washington	2	40
5	Jefferson	43	870
	Oldham	20	425
6	Boone	11	260
	Campbell	11	241
	Carroll	3	60
	Gallatin	1	20
	Grant	2	40
	Harrison	3	60
	Kenton	12	245
	Pendleton	1	20
7	Bourbon	16	340
	Clarke	36	745
	Fayette	21	445
	Franklin	17	340
	Henry	67	1,401
	Jessamine	12	245
	Owen	12	245
	Scott	2	40
	Shelby	15	300
	Woodford	16	334
8	Adair	15	300
	Anderson	1	20
	Boyle	36	779
	Garrard	18	360
	Lincoln	2	40
	Madison	13	260
	Mercer	17	470
	Pulaski	7	145
	Taylor	3	60
9	Estill	1	20
	Laurel	2	40
	Lee	1	20
	Letcher	1	20
	Montgomery	25	530
	Pike	1	20
	Whitley	1	200
10	Bath	1	36
	Bracken	3	60
	Carter	1	20
	Fleming	1	20
	Greenup	1	20
	Lawrence	2	40
	Lewis	2	40
	Mason	11	220
	Nicholas	1	20
	Powell	1	20
Total		942	20,323

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1882—Continued.

LOUISIANA.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
THE STATE.			
2	1	2	40
3	7	11	220
4	5	41	882
5	3	2	40
6	4	10	200
Total	20	66	1,382

Congressional districts.	Counties.	No. of applicants.	No. of fish.
2	Orleans	2	40
3	Assumption	2	40
3—Cont'd	Iberia	1	20
	La Fayette	1	20
	La Fourche	1	20
	Saint Martin	1	20
	Saint Mary	1	20
	Terre Bonne	4	80
4	Bienville	4	80
	Caddo	18	420
	De Soto	3	60
	Natchitoches	7	142
	Webster	9	180
5	Claiborne	1	20
	Jackson	1	20
	Ouachita	0	0
6	East Baton Rouge	1	20
	East Feliciana	3	60
	Saint Landry	5	100
	West Feliciana	1	20
Total		66	1,382

MAINE.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
THE STATE.			
1	2	4	80
2	1	1	20
3	1	1	20
4	1	1	20
5	1	1	20
Total	5	8	160
Number of fish shipped to the State commissioner for distribution unaccounted for			375
Grand total			535

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Cumberland	1	20
	York	3	60
2	Sagadahoc	1	20
3	Somerset	1	20
4	Piscataquis	1	20
5	Waldo	1	20
Total		8	160

MARYLAND.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
THE STATE.			
1	7	10	279
2	3	19	380
3 and 4	2	30	610
5	5	17	340
6	3	26	560
Not given	1	1	50
Total	21	103	2,219
Number of fish shipped to the State commissioner for distribution unaccounted for			500
Number of fish deposited in the Patapsco River at Laurel			1,500
Grand total			4,219

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Caroline	1	20
	Dorchester	1	20
	Kent	1	20
	Queen Anne	2	75
	Talbot	3	100
	Wicomico	1	24
	Worcester	1	20
2	Carroll	6	120
	Cecil	3	60
	Harford	10	200
3 and 4	Baltimore	12	240
4	Frederick	18	370
5	Anne Arundel	6	120
	Charles	2	40
	Howard	4	80
	Prince George's	3	60
	Saint Mary's	2	40
6	Garrett	1	20
	Montgomery	18	370
	Washington	7	170
Not given	Crumpton	1	50
Total		103	2,219

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1882—Continued.

MASSACHUSETTS.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
THE STATE.			
1	2	9	200
2	3	9	180
3 and 4	1	3	60
5 and 7	2	10	200
8	1	13	320
10 and 11	4	14	285
Total	13	58	1,245

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Barnstable	7	160
	Dukes	2	40
2	Bristol	3	60
	Norfolk	4	80
	Plymouth	2	40
3 and 4	Suffolk	3	60
5 and 7	Middlesex	7	140
7	Essex	3	60
8	Worcester	13	320
10	Franklin	1	20
	Hampshire	1	20
10 and 11	Hampden	9	185
11	Berkshire	3	60
Total		58	1,245

MICHIGAN.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
THE STATE.			
1	1	3	60
2	2	5	100
3	3	8	250
4	4	8	160
5	6	8	160
6	1	5	120
7	2	3	60
9	2	2	40
Not given	1	1	20
Total	22	43	970

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Wayne	3	60
2	Hillsdale	2	40
2—Cont'd	Washtenaw	3	60
3	Barry	4	80
	Calhoun	2	130
	Jackson	2	40
4	Berrien	2	40
	Cass	2	40
	Kalamazoo	1	20
	Saint Joseph	3	60
5	Allegan	1	20
	Ionia	1	20
	Kent	1	20
	Muskegon	1	20
	Ottawa	2	40
	Shiwassee	2	40
6	Oakland	5	120
7	Lapeer	1	20
	Macomb	2	40
9	Benzie	1	20
	Wexford	1	20
Not given	Oscoda	1	20
Total		43	970

MINNESOTA.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
THE STATE.			
1	9	23	490
2	6	7	140
3	9	19	412
Total	24	49	1,042
Number of fish shipped to the State commissioner for distribution unaccounted for			5,050
Grand total			6,092

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Blue Earth	1	20
	Faribault	2	40
	Fillmore	8	185
	Freeborn	2	41
	Mower	2	40
	Murray	2	44
	Pipestone	1	20
	Waseca	4	80
2	Watonwan	1	20
	Carver	1	20
	Dakota	1	20
	Lyon	1	20
	McLeod	1	20
	Rice	1	20

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1882—Continued.

MINNESOTA—Continued.

Congressional districts.	Counties.	No. of applicants.	No. of fish.	Congressional district.	Counties.	No. of applicants.	No. of fish.
3	Scott	2	40	3—Continued	Ramsey	2	60
	Becker	3	60		Stearns	1	20
	Clay	2	40		Washington	1	20
	Hennepin	4	80		Wright	1	20
	Otter Tail	4	80				
	Polk	1	32	Total		49	1,042

MISSISSIPPI.

Congressional districts.	No of counties.	No. of applicants.	No. of fish.
THE STATE.			
1	11	77	1,524
2	8	147	2,961
3	9	111	2,224
4	10	69	1,397
5	8	71	1,420
6	7	34	680
Total	53	509	10,206

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Alcorn	17	340
	Chickasaw	9	141
	Clay	6	120
	Itawamba	1	20
	Lee	9	180
	Lowndes	3	60
	Monroe	7	143
	Oktibbeha	8	180
	Pontotoc	12	240
	Prentiss	3	60
	Tishomingo	2	40
2	Benton	10	201
	De Soto	17	340
	Lafayette	27	560
	Marshall	35	700
	Panola	33	660
	Tate	14	280
	Tippah	3	60
	Yalabusha	8	160
3	Attala	6	120
	Carroll	5	100
	Choctaw	10	200
	Grenada	4	80
	Kemper	3	60
	Montgomery	1	20
	Neshoba	3	60
	Noxubee	36	724
	Winston	43	860
4	Clarke	1	20
	Holmes	11	221
	Jones	1	20
	Lauderdale	8	160
	Leake	4	80
	Madison	13	276
	Scott	19	380
	Smith	5	100
	Wayne	1	20
	Yazoo	6	120
5	Amite	3	60
	Amite	2	40
	Copiah	15	300
	Hancock	1	20
	Hinds	36	720
	Lincoln	6	120
	Pike	2	40
	Rankin	4	80
	Simpson	2	40
6	Adams	3	60
	Bolivar	3	60
	Claiborne	3	60
	Jefferson	1	20
	Warren	8	160
	Washington	7	140
	Wilkinson	9	180
Total		509	10,206

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1882—Continued.

MISSOURI.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
THE STATE.			
1	4	17	141
1, 2, and 3	1	16	376
4	4	7	140
5	2	5	100
6	12	69	1,530
7	6	39	819
8	4	14	280
9	5	11	220
10	4	11	220
11	6	63	1,262
12	8	27	541
13	2	6	122
Total	58	285	5,751
Number of fish shipped to the State commissioner for distribution unaccounted for			9,280
Grand total			15,031

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Madison	2	40
	Saint François	2	40
	Saint Genevieve	2	41
	Washington	1	20
1, 2, and 3	Saint Louis	16	376
4	Cape Girardeau	2	40
	Perry	1	20
	Reynolds	1	20
	Stoddard	3	60
5	Crawford	4	80
	Maries	1	20
6	Barton	4	120
	Bates	6	120
	Dade	1	20
6—Cont'd	Greene	18	370
	Henry	15	300
	Jasper	5	120
	Lawrence	6	200
	McDonald	3	60
	Newton	1	20
	Saint Clair	6	120
	Vernon	1	20
	Webster	3	60
7	Benton	1	20
	Cole	1	20
	Johnson	15	300
	Moniteau	16	320
	Pettis	5	139
	Polk	1	20
8	Cass	3	60
	Clay	3	60
	Jackson	7	140
	Platte	1	20
9	Buchanan	1	20
	De Kalb	1	20
	Gentry	4	80
	Holt	2	40
	Worth	3	60
10	Harrison	2	40
	Linn	1	20
	Randolph	6	120
	Sullivan	2	40
11	Boone	17	341
	Carroll	1	20
	Howard	3	60
	La Fayette	24	480
	Ray	1	21
	Saline	17	340
12	Adair	3	60
	Lewis	1	20
	Knox	1	20
	Macon	3	60
	Marion	8	161
	Schuyler	3	60
	Scotland	5	100
	Shelby	3	60
13	Audrain	3	62
	Montgomery	3	60
Total		285	5,751

NEBRASKA.

Congressional district.	Counties.	No. of applicants.	No. of fish.
At large	Cass	1	20
	Cheyenne	1	20
	Clay	1	25
	Dixon	1	25
	Douglas	2	49
	Holt	1	20
	Howard	1	20
	Knox	1	20
	Lancaster	3	60
	Lincoln	1	25
	Nemaha	1	25
At large—C'd.	Nuckolls	1	20
	Otoe	2	40
	Pawnee	3	70
	Richardson	2	40
	Saline	1	20
	Saunders	1	20
	Washington	1	20
	York	1	25
Total		26	564

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1882—Continued.

NEVADA.

Congressional district.	Counties.	No. of applicants.	No. of fish.
At large	Douglas	2	40
	Elko	1	30
	Eureka	2	40
	Humboldt	1	20
	Nye	1	20
At large—C'd.	Ormsby	1	20
	White Pine	1	20
Total		9	190

NEW HAMPSHIRE.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
THE STATE.			
1	3	6	137
2	2	5	140
3	2	4	80
Total	7	15	357

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Belknap	1	20
	Rockingham	2	57
	Stafford	3	60
2	Hillsborough	3	60
	Merrimack	2	80
3	Cheshire	2	40
	Grafton	2	40
Total		15	357

NEW JERSEY.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
THE STATE.		16	
1	4	21	320
2	4	10	438
3	3	19	200
4	4	34	386
5	3		680
Total	18	100	2,018
Number of fish shipped to the State commissioner for distribution unaccounted for			2,000
Grand total			4,018

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Camden	6	120
	Cumberland	2	40
	Gloucester	6	120
	Salem	2	40
2	Atlantic	9	198
	Burlington	11	220
	Mercer	1	20
	Ocean	0	0
3	Middlesex	4	80
	Monmouth	4	80
	Union	2	40
4	Hunterdon	4	85
	Somerset	7	140
	Sussex	5	100
	Warren	3	61
5	Bergen	1	20
	Morris	29	580
	Passaic	4	80
6	Essex	0	0
Total		100	2,018

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1882—Continued.

NEW MEXICO.

Congressional district.	Counties.	No. of applicants.	No. of fish.
At large	Grant	2	40
	Lincoln	1	20
	Mora	3	60
	Socorro	1	20
	Taos	1	20
	Valencia	1	20
Total		9	180

NEW YORK.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
THE STATE.			
1	3	27	545
2, 3, 4, 5, 6, 7, 8, 9, 10, and 11	1	26	667
12	1	3	60
13	3	26	591
14	3	70	1,444
15	2	8	160
17	2	5	100
20	2	3	80
21	1	3	67
22	2	5	100
23	1	18	423
24	1	3	80
25	1	2	60
26	1	2	40
27	2	7	179
28	4	10	213
29	3	9	180
30	2	4	80
31	2	4	80
32	1	1	20
33	2	7	140
Total	40	233	5,309
Number of fish shipped to the State commissioner for distribution unaccounted for			1,900
Grand total			7,209

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Queens	11	220
	Richmond	3	60
	Suffolk	13	265
2, 3, 4, 5, 6, 7, 8, 9, 10, and 11	New York	26	667
12	Westchester	3	60
13	Columbia	6	120
	Dutchess	18	431
	Putnam	2	40
14	Orange	53	1,104
	Rockland	5	100
	Sullivan	12	240
15	Schoharie	1	20
	Ulster	7	140
17	Rensselaer	2	40
	Washington	3	60
20	Fulton	2	60
	Montgomery	1	20
21	Delaware	3	67
22	Jefferson	1	20
	Lewis	4	80
23	Oneida	18	423
24	Madison	3	80
25	Onondaga	2	60
26	Cayuga	2	40
27	Livingston	3	69
	Ontario	4	110
28	Broome	5	100
	Schuyler	2	53
	Tioga	1	20
	Tompkins	2	40
29	Allegany	6	120
	Chemung	1	20
	Steuben	2	40
30	Monroe	2	40
	Orleans	2	40
31	Genesee	2	40
	Niagara	2	40
32	Erie	1	20
33	Cattaraugas	2	40
	Chautauqua	5	100
Total		233	5,309

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1882—Continued.

NORTH CAROLINA.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
THE STATE.			
1	9	18	374
2	8	112	2,325
3	10	128	2,839
4	9	157	3,426
5	8	249	5,158
6	10	202	4,355
7	11	156	3,252
8	14	166	3,537
Not given	1	14	281
Total	80	1,202	25,547

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Bertie	2	40
	Chowan	1	20
	Hertford	1	20
	Martin	2	40
	Pamlico	1	20
	Pasquotank	1	20
	Perquimans	2	40
	Pitt	6	134
	Washington	2	40
2	Edgecombe	17	360
	Greene	6	120
	Halifax	18	360
	Lenoir	4	80
	Northampton	5	120
	Warren	25	520
	Wayne	22	440
	Wilson	15	325
3	Bladen	3	76
	Cumberland	16	379
	Carteret	1	20
	Columbus	2	40
	Duplin	42	864
	Moore	22	467
	New Hanover	6	270
	Onslow	2	40
	Pender	6	120
	Sampson	28	563
4	Chatham	20	418
	Durham	13	296
	Franklin	17	441
4—Cont'd	Granville	17	350
	Harnett	7	174
	Johnston	27	540
	Nash	6	134
	Orange	19	421
	Wake	31	652
5	Alamance	36	740
	Caswell	30	613
	Davidson	10	250
	Guilford	84	1,720
	Person	14	280
	Randolph	14	280
	Rockingham	45	955
	Stokes	16	320
6	Anson	20	400
	Cabarrus	16	320
	Catawba	17	346
	Gaston	25	521
	Lincoln	46	998
	Mecklenburg	47	1,066
	Montgomery	1	20
	Richmond	6	184
	Robeson	12	240
	Union	12	260
7	Alleghany	2	40
	Alexander	3	60
	Ashe	3	60
	Davie	7	140
	Forsythe	42	880
	Iredell	36	722
	Rowan	37	810
	Surry	8	160
	Watauga	1	20
	Wilkes	7	160
	Yadkin	10	200
8	Buncombe	26	544
	Burke	6	170
	Caldwell	10	225
	Clay	1	20
	Cleveland	16	373
	Haywood	5	100
	Henderson	31	658
	McDowell	6	120
	Macon	5	107
	Madison	16	320
	Mitchell	7	140
	Polk	3	60
	Rutherford	33	660
	Transylvania	1	40
Not given	Vance	14	281
Total		1,202	25,547

OHIO.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
THE STATE.			
1 and 2	1	15	310
3	4	39	780
4	4	11	220
5	3	5	110
6	4	9	199
7	5	20	417
8	5	21	435
9	6	30	579
10	3	10	216
11	3	11	230
12	3	29	780
13	3	30	691
14	5	33	807
15	5	15	310
THE STATE—Continued.			
16	5	18	426
17	4	42	902
18	4	28	574
19	4	35	718
20	1	17	348
Total	72	418	9,052
Number of fish shipped to the State commissioner and agents for distribution unaccounted for			2,700
Grand total			11,752

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1882—Continued.

OHIO—Continued.

Congressional districts.	Counties.	No. of applicants.	No. of fish.	Congressional districts.	Counties.	No. of applicants.	No. of fish.
1 and 2	Hamilton	15	310	11 Cont'd	Vinton	3	60
3	Butler	11	220	12	Fairfield	11	225
	Clermont	12	240		Franklin	15	460
	Clinton	9	180		Perry	3	95
	Warren	7	140	13	Coshocton	4	101
4	Darke	2	40		Licking	19	445
	Greene	4	80		Muskingum	7	145
	Montgomery	3	60	14	Ashland	6	120
	Preble	2	40		Cranford	1	20
5	Allen	3	70		Holmes	7	142
	Mercer	1	20		Richland	11	225
	Paulding	1	20		Wyandot	8	300
6	Lawrence	3	60	15	Athens	6	120
	Lucas	3	75		Meigs	2	50
	Williams	1	24		Monroe	1	20
	Wood	2	40		Morgan	2	40
7	Adams	4	80		Washington	4	80
				16	Belmont	10	210
	Brown	1	20		Guernsey	2	85
	Highland	10	206		Harrison	2	41
	Pike	3	60		Jefferson	3	60
	Ross	2	51		Noble	1	30
8	Champaign	7	140	17	Carroll	3	65
	Clarke	4	80		Columbiana	27	573
	Logan	2	40		Mahoning	1	24
	Madison	2	40		Stark	11	240
	Miami	6	135	18	Lorain	6	122
9	Delaware	6	130		Medina	2	41
	Hardin	3	64		Summit	8	171
	Knox	6	160		Wayne	12	240
	Marion	1	25	19	Ashtabula	7	140
	Morrow	3	60		Geauga	15	300
	Union	11	140		Portage	8	178
10	Erie	1	20		Trumbull	5	100
	Hancock	2	40	20	Cuyahoga	17	348
	Huron	7	156				
11	Hocking	4	90	Total		418	9,052
	Scioto	4	80				

OREGON.

Congressional districts.	Counties.	No. of applicants.	No. of fish.	Congressional districts.	Counties.	No. of applicants.	No. of fish.
At large	Baker	1	20	At large—C'd.	Polk	1	20
	Benton	1	20		Tillamook	1	20
	Clackamas	3	60		Union	1	20
	Clatsop	1	20		Umatilla	1	20
	Douglas	2	40		Wasco	1	20
	Lake	2	40		Washington	4	80
	Lane	5	100		Yam Hill	2	40
	Linn	2	40				
	Marion	4	80	Total		48	960
	Multnomah	16	320				

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1882—Continued.

PENNSYLVANIA.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
THE STATE.			
1, 2, 3, 4, and 5	1	23	563
6	2	72	1,583
7	2	27	570
8	1	62	1,326
9	1	10	220
10	2	14	287
11 and part of 12	4	14	282
12, balance	1	4	80
13	1	13	273
14	3	17	365
15	3	15	333
16	4	5	100
17	5	38	764
18	5	16	341
19	3	24	513
20	5	14	300
21	3	16	340
23	1	13	260
24	3	41	882
25	5	25	536
26	3	31	630
27	2	9	200
Total	60	503	10,748
Number of fish shipped to the State commissioner and agents for distribution unaccounted for			2,060
Grand total			12,808

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1, 2, 3, 4, and 5	Philadelphia	23	563
6	Chester	59	1,279
	Delaware	13	304
7	Bucks	12	260
	Montgomery	15	310
8	Berks	62	1,326
9	Lancaster	10	220
10	Lehigh	11	225
	Northampton	3	62
11	Columbia	4	80
11	Monroe	3	60
	Pike	1	22
11 and 12	Luzerne	6	120
12	Lackawanna	4	80
13	Schuylkill	13	273
14	Dauphin	6	120
	Lebanon	6	145
	Northumberland	5	100
15	Bradford	5	112
	Susquehanna	8	180
	Wayne	2	41
16	Cameron	1	20
	Lycoming	2	40
	Sullivan	1	20
	McKean	1	20
17	Bedford	3	60
	Blair	10	200
	Cambria	9	184
	Somerset	9	180
	Tioga	7	140
18	Franklin	3	60
	Huntingdon	6	140
	Juniata	5	100
	Perry	1	20
	Snyder	1	21
19	Adams	9	182
	Cumberland	1	22
	York	14	309
20	Centre	1	20
	Clearfield	2	40
	Elk	2	40
	Mifflin	3	60
	Mifflin	4	100
	Union	2	40
21	Fayette	3	60
	Greene	5	100
	Westmoreland	8	180
23	Allegheny	13	260
24	Beaver	9	180
	Lawrence	11	221
	Washington	21	481
25	Armstrong	8	160
	Clarion	3	76
	Forest	1	20
	Indiana	10	220
	Jefferson	3	60
26	Butler	6	120
	Crawford	8	163
	Mercer	17	347
27	Erie	3	60
	Venango	6	140
Total		503	10,748

RHODE ISLAND.

Congressional district.	Counties.	Number of applicants.	Number of fish.
1	Bristol	1	20
	Newport	2	40
	Providence	4	80
Total		7	140

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1882—Continued.

SOUTH CAROLINA.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
THE STATE.			
1	7	34	700
2	1	20	400
3	7	168	3,435
4	7	146	3,073
5	5	92	1,843
Not given	5	40	880
Total	29	500	10,331

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Darlington	4	80
	Horry	2	40
	Marion	6	140
	Sumter	14	280
	Williamsburg	1	20
	Charleston	5	100
1—Cont'd.	Clarendon	2	40
2	Orangeburg	20	400
3	Abbeville	10	221
	Anderson	38	778
	Laurens	32	660
	Newberry	9	184
	Oconee	45	911
	Pickens	8	160
	Richland	26	521
4	Chester	17	340
	Greenville	54	1,115
	Kershaw	2	40
	Lancaster	5	103
	Spartanburg	30	640
	Union	16	340
	York	22	495
5	Aiken	11	220
	Aiken	11	220
	Barnwell	28	563
	Beaufort	1	20
	Colleton	9	180
	Edgefield	32	640
Not given	Berkeley	1	20
	Lexington	39	860
Total		500	10,331

TENNESSEE.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
THE STATE.			
1	9	68	1,340
2	7	28	560
3	8	17	340
4	2	12	240
5	3	5	100
6	1	7	140
7	3	5	100
8	6	22	440
9	8	36	720
10	3	51	1,020
Total	50	251	4,000
Number of fish shipped to the State commissioner for distribution unaccounted for			2,300
Grand total			6,300

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Carter	2	20
	Claiborne	8	160
	Grainger	5	100
	Greene	18	360
	Hamblen	8	160
	Hawkins	2	40
	Sullivan	5	100
	Unicoi	3	60
	Washington	17	340
2	Anderson	1	20
	Blount	1	20
2—Cont'd.	Campbell	3	60
	Jefferson	6	120
	Knox	6	120
	Loudon	1	20
	Monroe	10	200
3	Bradley	2	40
	Grundy	1	20
	Hamilton	7	140
	McMinn	1	20
	Marion	1	20
	Polk	1	20
	Warren	1	20
	White	3	60
4	Fentress	2	40
	Wilson	10	200
5	Coffee	2	40
	Franklin	1	20
	Lincoln	2	40
6	Montgomery	7	140
7	Giles	1	20
	Maury	3	60
	Williamson	1	20
8	Carroll	4	80
	Decatur	1	20
	Henderson	3	60
	Henry	1	20
	McNairy	1	20
	Madison	12	240
9	Crockett	2	40
	Dyer	2	40
	Gibson	10	200
	Haywood	5	100
	Lauderdale	1	20
	Obion	1	20
	Tipton	6	120
	Weakley	9	180
10	Fayette	24	480
	Hardeman	8	160
	Shelby	19	380
Total		251	4,000

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1882—Continued.

TEXAS.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
THE STATE.			
1	8	33	660
2	15	115	2,321
3	18	395	7,963
4	16	163	3,272
5	11	93	1,973
6	11	50	1,049
Not given	4	11	221
Total	83	860	17,459
Number of fish shipped to the State commissioner and agents for distribution unaccounted for			523
Number of fish deposited in the Trinity River at Dallas			1,000
Grand total			18,982

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Anderson	16	320
	Angelina	1	20
	Cherokee	6	120
	Houston	3	60
	Panola	3	60
	Rusk	1	20
	Shelby	1	20
	Trinity	2	40
2	Camp	3	60
	Cass	7	140
	Fannin	7	140
	Gregg	1	20
	Harrison	4	80
	Hopkins	17	340
	Hunt	5	100
	Lamar	10	220
	Marion	3	61
	Red River	50	1,000
	Smith	3	60
	Titus	1	20
	Upshur	1	20
	Van Zandt	1	20
	Wood	2	40
3	Clay	3	60
	Callahan	6	203
	Collin	62	1,160
	Cook	13	280
	Dallas	25	500
3—Cont'd	Denton	20	400
	Eastland	3	60
	Ellis	54	1,120
	Erath	2	40
	Grayson	104	2,080
	Hill	44	880
	Jack	1	20
	Johnson	24	480
	Kaufman	8	160
	Parker	4	80
	Palo Pinto	2	40
	Stevens	4	80
	Tarrant	16	320
4	Bell	14	298
	Bosque	1	34
	Brazos	9	180
	Falls	2	40
	Freestone	1	20
	Grimes	16	320
	Harris	6	120
	Leon	4	80
	Limestone	34	680
	McLennan	6	120
	Montgomery	12	240
	Navarro	32	620
	Robertson	20	400
	San Jacinto	2	40
	Walker	2	40
	Waller	2	40
5	Austin	1	20
	Bastrop	29	621
	Brazoria	1	20
	Burleson	1	20
	Colorado	5	100
	Fayette	32	640
	Lavaca	1	20
	Matagorda	4	80
	Milam	9	192
	Travis	1	80
	Washington	9	180
6	Bexar	13	280
	Blanco	1	20
	Caldwell	4	89
	De Witt	1	20
	Duval	9	180
	Encinal	1	20
	Guadalupe	1	20
	Live Oak	1	20
	Neuces	17	360
	Presidio	1	20
	San Patricio	1	20
Not given	Brown	3	60
	El Paso	5	101
	Morris	2	40
	Wheeler	1	20
Total		860	17,459

UTAH TERRITORY.

Congressional district.	Counties.	No. of applicants.	No. of fish.
At large	Box Elder	1	20
	Iron	1	20
	Kane	1	20
	Millard	4	80
	Piute	3	60
	Salt Lake	4	80
At large—C'd.	Summit	2	40
	Utah	1	20
	Weber	1	20
Total		18	360

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1882—Continued.

VERMONT.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
THE STATE.			
1	1	4	80
2	2	2	40
3	1	1	20
Total	4	7	140

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Rutland	4	80
2	Caledonia	1	20
	Windham	1	20
3	Orleans	1	20
Total		7	140

VIRGINIA.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
THE STATE.			
1	9	23	462
2	3	6	120
3	5	71	1,458
4	10	47	989
5	6	68	1,369
6	7	64	1,367
7	8	271	5,465
8	11	120	2,507
9	5	18	360
Total	64	688	14,097
Number of fish deposited in Bull River at Clifton Station			1,500
Grand total			15,597

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Essex	4	80
	King and Queen	2	40
	King George	3	62
	King William	2	40
	Middlesex	4	80
	Northampton	2	40
	Northumberland	1	20
	Spottsylvania	3	60
	Stafford	2	40
2	James City	1	20
	Nansemond	2	40
	Southampton	3	60
3	Caroline	22	440
	Chesterfield	4	80
	Hanover	10	200
	Henrico	24	506
	Louisa	11	232
4	Amelia	4	80
	Appomattox	1	20
4—Cont'd	Brunswick	1	20
	Cumberland	2	40
	Dinwiddie	7	140
	Greenville	1	20
	Lunenburg	9	200
	Mecklenburg	13	287
	Powhattan	1	20
	Prince Edward	8	162
5	Floyd	1	20
	Franklin	1	20
	Halifax	6	125
	Henry	3	60
	Patrick	1	20
	Pittsylvania	56	1,124
6	Amherst	1	20
	Bedford	13	263
	Botetourt	14	280
	Buckingham	4	120
	Campbell	4	80
	Nelson	2	40
	Rockbridge	26	564
7	Albemarle	35	700
	Augusta	14	282
	Fluvanna	3	60
	Gouchland	3	60
	Greene	2	40
	Page	6	120
	Rockingham	169	3,403
	Shenandoah	39	800
8	Alexandria	1	20
	Clarke	9	180
	Culpeper	4	80
	Fairfax	12	242
	Fauquier	49	1,040
	Frederick	7	180
	Loudon	16	320
	Madison	4	85
	Orange	12	240
	Rappahannock	3	60
	Warren	3	60
9	Montgomery	2	40
	Pulaski	1	20
	Roanoke	5	100
	Washington	8	160
	Wythe	2	40
Total		688	14,097

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1882—Continued.

WASHINGTON TERRITORY.

Congressional district.	Counties.	No. of applicants.	No. of fish.	Congressional district.	Counties.	No. of applicants.	No. of fish.
At large	Cowlitz	2	40	At large—C'd.	Spokane	3	60
	Island	1	20		Walla Walla	7	140
	Jefferson	2	40		Whatcom	3	60
	Kings	1	20		Yakima	2	40
	Pacific	1	20				
	Pierce	3	60	Total		25	500

WEST VIRGINIA.

Congressional districts.	No. of counties.	No. of applicants.	No. of fish.
THE STATE.			
1	9	19	388
2	13	76	1,555
3	7	21	420
Total	29	116	2,363
Number of fish shipped to the State commissioner for distribution unaccounted for			140
Grand total			2,503

Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Brooke	3	60
	Gilbert	2	40
	Harrison	2	40
	Lewis	1	20
1—Cont'd	Marshall	1	20
	Ohio	5	101
	Ritchie	2	42
	Wetzel	2	45
	Wood	1	20
2	Barbour	1	20
	Grant	6	120
	Hampshire	9	180
	Hardy	3	60
	Jefferson	9	180
	Marion	11	255
	Monongalia	3	60
	Monroe	17	340
	Morgan	2	40
	Preston	10	200
	Pocahontas	1	20
	Randolph	2	40
	Taylor	2	40
3	Greenbrier	12	240
	Mason	3	60
	Mercer	1	20
	Raleigh	1	20
	Roane	1	20
	Summers	2	40
	Wayne	1	20
Total		116	2,363

WISCONSIN.

Congressional district.	No. of counties.	No. of applicants.	No. of fish.	Congressional district.	No. of counties.	No. of applications.	No. of fish.
THE STATE.				THE STATE—Continued.			
1	3	5	100	6	1	1	21
2	3	5	100	7	5	8	160
3	1	1	20	8	3	3	60
4	2	6	120				
5	2	2	40	Total	20	31	621

DISTRIBUTION OF CARP IN THE UNITED STATES IN 1882—Continued.

WISCONSIN—Continued.

Congressional districts.	Counties.	No. of applicants.	No. of fish.	Congressional districts.	Counties.	No. of applicants.	No. of fish.
1	Racine	1	20	6	Winnebago	1	21
	Rock	1	20	7	La Crosse	4	80
1—Cont'd	Walworth	3	60		Monroe	1	20
2	Columbia	1	20		Pepin	1	20
	Dane	1	20		Pierce	1	20
	Sauk	2	60		Waukesha	1	20
3	Crawford	3	20	8	Chippewa	1	20
4	Milwaukee	1	40		Dunn	1	20
	Washington	4	80		Portage	1	20
5	Manitowoc	1	20				
	Sheboygan	1	20	Total		31	621

WYOMING TERRITORY.

Congressional district.	Counties.	Number of applicants.	Number of fish.
At large	Carbon	1	20
	Laramie	2	40
	Uintah	1	20
Total		4	80

FOREIGN COUNTRIES.

	Number of applicants.	Number of fish.
Cuba	1	25
Bogota	1	50
Mexico	2	70
Total	4	145

XXXIX.—REPORT ON THE DISTRIBUTION OF CARP TO JULY 1, 1881, FROM YOUNG REARED IN 1879 AND 1880.

By Chas. W. Smiley.

The carp which were imported from Germany by the United States Fish Commission were placed by Mr. Rud. Hessel, who had accompanied the shipment from Europe, in the Druid Hill Park ponds, at Baltimore, on the 26th of May, 1876. These consisted of 227 leather and mirror carp and 118 scale carp.* In the spring of 1878 there were transferred to Washington 65 leather carp and 48 scale carp. These were placed in the ponds which had meantime been prepared for them. The carp which remained in Baltimore under the charge of Mr. T. B. Ferguson spawned in 1878 but hybridized with gold-fish, and the young being worthless were destroyed. The carp in the Washington ponds first spawned in 1879, and over 6,000 young were reared for distribution.† A similar number was reared at the Druid Hill ponds and these were distributed largely to citizens of Maryland, who were informed that they could apply in person at the park for the fish. The total number of carp sent out in 1879 was 12,265, to over 300 persons in 25 States and Territories. Among the recipients were various State commissioners who redistributed their fish.

In 1880 the yield of young fish was very much larger, aggregating 66,165 carp for distribution.

In anticipation of a supply of young carp, applications began to be filed with the Commissioner as early as the fall of 1876. The records show the earliest applications to have been as follows:

September, 1876, from B. B. Redding, San Francisco, Cal.
October, 1876, from Hon. Simon Cameron, Harrisburg, Pa.

The increase in applications during 1877, 1878, and 1879 is shown in the following table:

Table showing the number of carp applications filed with the United States Fish Commission monthly during three years ending December 31, 1879. ‡

Month.	1877.	1878.	1879.	Month.	1877.	1878.	1879.
January	3	12	13	August	2	6	18
February	1	9	25	September	....	15	12
March	1	5	20	October	....	7	19
April	....	6	14	November	2	6	33
May	2	24	15	December	3	18	43
June	5	27	11				
July	3	9	12	Total	22	144	235

* Report of the United States Fish Commission, 1877, p. 43.

† Report of the United States Fish Commission, 1879, p. xxxvi.

‡ Several of these applications were from State commissions for carp to redistribute, and thus a much larger number of ultimate receipts is indicated.

After January 1, 1880, the number of applicants rapidly increased, so that the number of applications filed that year was nearly 2,000.

Number of applications supplied in 1879, 1880, and the spring of 1881, from the crops of 1879 and 1880, as shown in detail in the list at the close of this report.

	1879.	1880.	1881.	Total.
Alabama	10	30	11	51
Arkansas		3		3
California	3			3
Colorado	17	16		33
Connecticut		49	6	55
Dakota		1	1	2
Delaware	6	16	3	25
District of Columbia	4	11	5	20
Florida	1		17	18
Georgia	39	99	25	163
Illinois	2	23	8	33
Indiana	5	35	8	48
Iowa		8	1	9
Kansas	1	22	4	27
Kentucky	11	135	49	195
Louisiana		1	7	8
Maine		4	1	5
Maryland	77	283	76	436
Massachusetts		45	1	46
Michigan		17	2	19
Minnesota		7	1	8
Mississippi	12	98	21	131
Missouri	11	37	9	57
Nebraska		11	3	14
New Hampshire		4		4
New Jersey	2	80	12	94
New York	16	127	21	164
North Carolina	1	55	6	62
Ohio	6	119	22	147
Pennsylvania	7	103	39	149
Rhode Island		14		14
South Carolina	21	10	2	33
Tennessee	11	94	16	121
Texas	34	132	18	184
Vermont		9		9
Virginia	14	185	31	230
West Virginia	3	31	22	56
Wisconsin	1	18	3	22
Miscellaneous		2		2
Total	315	1,934	451	2,700

List of names of persons who received carp in the fall of 1879, for distribution to other parties.

	Carp.
B. B. Redding, San Francisco, Cal	500
W. E. Sisty, Brookvale, Colo	217
J. P. Delaney, Seaford, Del	225
Hon. Eli Saulsbury, Dover, Del	275
J. T. Henderson, Atlanta, Ga	242
Hon. Jas. B. Beck, Lexington, Ky	500
Hon. V. H. Manning, Holly Springs, Miss	155
J. G. W. Steedman, Saint Louis, Mo	240
E. G. Blackford, Fulton Market, New York	193
S. G. Worth, Morgantown, N. C	525
Col. A. P. Butler, Hamsburg, S. C	475
J. N. Collender, Nashville, Tenn	300
J. H. Dinkins, Austin, Tex	151
Col. Thos. Lewis, Salem, Va	512
Col. M. McDonald, Lexington, Va	250
	4,760

Young carp furnished by the Druid Hill Park ponds from the crop of 1879.

1879.			Carp.
Nov.	4.	For the Virginia Commission	250
	10.	To Messengers Ellis and Schuermann	1,000
	12.	Returned to Druid Hill Park ponds	1,000
	13.	For Pierre Lorillard, Jobstown, N. J	50
	13.	For Milton P. Pierce, Wenonah, N. J	30
Dec.	4.	To Messenger Ellis	580
	8.	For the Virginia Commission to H. B. Nichols	375
	8.	To Messenger Hamlen	500
	16.	For Hon. J. W. Casey, Milford, Del	40
	20.	To Messenger Ellis	600
		Total	4,425

With the production of several thousand young carp for distribution in the fall of 1879, to applicants distributed through most of the United States, the Commission was confronted with a new problem regarding the best method of placing them in the hands of applicants. Mr. T. B. Ferguson was placed in charge of this work. Substantially the same method was adopted which had been in use in the distribution of shad. This consisted in the use of a large wooden-bound tin can nearly filled with water. The cans were of two sizes, 5 and 10 gallons. The tin cans, when filled with water, were considered suitable for transporting 50 to 100 carp. Lots of from 100 to 500 were placed in the requisite number of cans and sent to State commissioners, Congressmen, and others who had agreed to receive them at central points and distribute them. Messengers of the Commission usually accompanied the shipments, and were instructed to change the water at convenient intervals. Nearly one-half the carp of 1879 was transferred in bulk to those persons in various States. Lists of persons to be supplied therefrom were forwarded with the fish, and the applicants notified by mail to apply in person or by representative to those who had undertaken this work. Many applicants in Maryland and places within easy reach of Baltimore and Washington were notified to come for their fish. Of course there was considerable expense attending the use of so large cans, weighing 60 pounds or more, and the sending of messengers to accompany each shipment. These expenses were borne in part by the United States Commission and partly by the State commissions.

In many cases, where a single applicant was to be supplied with but 15 or 20 fish, it was impossible for the carp to be accompanied by an attendant. Then packages were forwarded by express, suitable notice of the arrangements having been given in advance. In these cases the same 5 and 10 gallon cans were used and the recipient permitted his choice of paying the cost price of $2 for the can, or of returning it by express. Usually there was no opportunity for the change of water in the cans while in express transit. However, there were not many losses for the lack of it. But the express charges often came to several dollars.

Substantially the same methods continued in use throughout the distribution of 1879–'80 and the spring of 1881. But the system was destined to be revolutionized by dispensing, very largely, with attendants, and by reducing the vessels from 10 gallons to 4 quarts capacity. But the experiments which led to these improvements were not undertaken until November, 1881. These have been described elsewhere, and the more recent methods reported upon by Col. M. McDonald.*

Carp furnished by Dr. Rud. Hessel from the Monument lot ponds, crop of 1880, *for distribution.*†

Date.	Name and address of person supplied.	Number and kind of carp.
1880.		
Oct. 3	(Delivered to Messenger Ellis)	500 L.
6	G. Obendorf, Kansas City, Mo	30 L.
12	Massachusetts Fish Commission	500 L.
13	T. Paxson, Leesburg, Va	20 L.
17	G. A. Creasy, Mount Airy, Va	20 L.
17	Samuel L. Smith, Mount Airy, Va	20 L.
20	O. Mullert, Cincinnati, Ohio	20 L.
22	Joseph Barlow, Howard County, Maryland	20 L.
25	Connecticut Fish Commission	400 L.
25	......do	400 S.
25	Michigan Fish Commission	800 S.
27	Massachusetts Fish Commission	800 S.
27	Rhode Island Fish Commission	200 S.
27	J. Shaw Margerum, Washington, Pa	20 S.
28	D. E. Mason, Prince George County, Virginia	20 S.
28	New York Fish Commission	1,000 S.
28	A. W. Smith, Wheaton, Md	20 L.
30	John T. Williams, York, Pa	20 S.
30	Robert P. Barry, Warrenton, Va	20 S.
30	C. Schultze, Surry County, Virginia	20 L.
31	Dr. E. Sterling, Cleveland, Ohio	1,200 S.
Nov. 1	Charles T. Brooks, Sandy Spring, Md	20 S.
1	Warwick P. Miller Spencerville, Md	20 S.
1	George Finley, Pittsburg, Va	600 S.
3	Messenger Davenport for Mr. Danley	420 S.
8	Milton P. Peirce, Wenonah, N. J	750 S.
8	Tennessee Fish Commission	1,000 S.
8	Illinois Fish Commission	800 S.
8	......do	20 L.
8	Missouri Fish Commission	1,200 S.
8	Virginia Fish Commission	80 L.
8	North Carolina Fish Commission	1,000 S.
10	Georgia Fish Commission	1,000 S.
11	Virginia Fish Commission	300 S.
11	C. S. White, Romney, W. Va	600 S.
11	J. P. Creveling, Marietta, Ohio	1,000 S.
11	Dr. E. G. Shortlidge, Wilmington, Del	80 S.
11	......do	20 L.
12	Dr. C. J. Morton, Toughkenamon, Pa	20 S.
12	New York Fish Commission	1,200 S.
12	George W. Spates, Poolesville, Md	100 L.
12	F. S. E. Fletcher, Montgomery County, Maryland	40 S.
12	S. B. Corbett, Alexandria, Va	20 S.
13	Virginia Fish Commission	200 S.
16	......do	200 S.
15	C. M. Manville, Towanda, Pa	20 S.
16	Hugh R. Garden, Warrenton, Va	20 S.
16	Jacob Lerch, Forestville, Md	20 L.
17	F. A. Tschiffely, jr., Beltsville, Md	20 L.
17	Georgia Fish Commission	450 L.
17	......do	400 S.
17	(Delivered to Messenger Ellis)	3,850 L.
17	......do	3,380 S.
17	Shotwell Powell, Keysville, Va	20 L.
18	Virginia Fish Commission	80 L.
18	Wm. J. Knott, Shepherdstown, W. Va	20 L.

* Bulletin of the Fish Commission, 1881; pp. 215–218; 1882, p. 94; Report of the Commissioner, 1881, pp. 1121–1126.

† His records of carp furnished from the crop of 1879 were lost at the time of the flood of February 12, 1880. L. is put for leather carp and S. for scale carp.

Carp furnished by Dr. Rud. Hessel from the Monument lot ponds, &c.—Continued.

Date.		Name and address of person supplied.	Number and kind of carp.
1880.			
Nov.	18	Georgia Fish Commission	1,000 L.
	19	Daniel Ammen, Beltsville, Md	20 L.
	20	Virginia Fish Commission	150 L.
	20	W. M. Curtis, Georgetown, D. C	20 L.
	20	South Carolina Fish Commission	700 L.
	22	Maryland Fish Commission	600 L.
	22	Virginia Fish Commission	150 L.
	22	Delaware Fish Commission	1,000 L.
	22	South Carolina Fish Commission	750 L.
	22	Tennessee Fish Commission	1,000 L.
	23	B. T. Palmer, Montgomery County, Maryland	20 L.
	25	Virginia Fish Commission	1,500 L.
	28	......do	150 L.
	29	Hugo Mullert, Cincinnati, Ohio	200 S.
	30	James Parker, Montgomery County, Maryland	50 L.
	30	C. White, Prince George's County, Maryland	25 L.
	30	A. B. Moon, Mount Airy, Va	40 S.
	30	North Carolina Fish Commission	600 L.
Dec.	1	New York Fish Commission	1,000 L.
	2	J. W. Gill, Millford, Va	50 L.
	2	F. M. Churchman, Indianapolis, Ind	25 L.
	2	Staunton Churchman, Indianapolis, Ind	25 L.
	3	(Delivered to Messenger Ellis)	7,190 L.
	3	......do	400 S.
	3	North Carolina Fish Commission	600 L.
	4	Georgia Fish Commission	1,000 L.
	5	Ohio Fish Commission	750 L.
	6	Hugo Mullert, Cincinnati, Ohio	210 L.
	6	G. W. Reansley, Charlestown, W. Va	50 L.
	6	Maryland Fish Commission	1,000 L.
	7	E. B. Isett, Spruce Creek, Pa	25 L.
	13	A. Pratt, Winchester, Va	20 L.
	13	P. W. Stoneback, Lilesville, N. C	40 L.
	13	E. Remington & Sons, Ilion, N. Y	50 L.
	14	W. B. Shaw, Washington, D. C	20 L.
	14	......do	20 S.
	15	G. A. Sammit, Boston, Mass	20 L.
	15	New York Fish Commission	1,000 L.
	17	F. A. Schnikle, Covington, Ky	20 L.
	17	Mississippi Fish Commission	1,000 L.
	18	Alabama Fish Commission	600 L.
	18	......do	300 S.
	25	West Virginia Fish Commission	280 L.
	27	Mississippi Fish Commission	800 L.
	27	Louisiana Fish Commission	1,000 L.
	28	William Bahme, Numidia, Pa	40 L.
	28	Copeland D. Epps, Nottoway Court-House, Va	40 L.
	28	John H. Patterson, Red Bank, N. J	40 L.
1881.			
Jan.	4	Texas Fish Commission	1,000 S.
	6	M. A. Miller, Gordonsville, Va	20 L.
	7	South Carolina Fish Commission	800 L.
	10	John A. Williams, New Salem, W. Va	40 L.
	10	Elias Sindel, Greenwood Lake, N. Y	50 L.
	10	P. R. George, Ringwood, N. J	50 L.
	11	P. W. Stoneback, Lilesville, N. C	40 S.
	11	Florida Fish Commission	700 L.
	15	M. A. Miller, Gordonsville, Va	50 S.
	17	Maryland Fish Commission	1,000 L.
	18	John Scott, Nevada, Iowa	50 L.
	20	Virginia Fish Commission	100 L.
	24	Georgia Fish Commission	700 S.
	24	Florida Fish Commission	1,250 S.
	25	R. Welby Carter, Purcellville, Va	40 L.
	26	Georgia Fish Commission	800 S.
	27	......do	1,000 S.
	27	W. G. Crenshaw, Rapid Ann, Va	25 S.
	31	Maryland Fish Commission	500 L.
	31	A. M. Chichester, Leesburg, Va	50 L.
	31	J. G. Mitchell, Lynchburg, Va	25 L.
	31	Philip Plaff, Pepin, Wis	25 S.
Feb.	1	North Carolina Fish Commission	1,000 S.
	3	Charles H. Emily, Moodus, Conn	25 S.
	3	Texas Fish Commission	1,000 S.
	8	Georgia Fish Commission	1,600 S.
	10	C. C. Straub, Milton, Pa	30 S.
	10	Samuel Wampler, Dayton, Ohio	30 S.
	22	O. S. Rimmer & Son, Kosciusko, Miss	50 S.

Carp furnished by Dr. Rud. Hessel, from the Monument lot ponds, &c.—Continued.

Date.	Name and address of person supplied.	Number and kind of carp.
1881.		
Feb. 22	G. T. Ager, Goshen, Ind	30 L.
25	Gen. O. E. C. Ord, Mexico City, Mexico	20 L.
Mar. 7	George W. Spates, Poolesville, Md	20 L.
7	William Sadler, New Salem, W. Va	40 S.
7	Samuel H. Hand, Reidsville, N. C	25 S.
8	Charles Reighter, Spencerville, Md	20 S.
8	A. Cooley, Ripon, Wis	30 S.
8	James L. Stewart, Arcadia, La	20 L.
8	Michael Langenstein, Fountain Creek, Ill	30 L.
8	J. Z. George, Winona, Miss	50 L.
8	John Ohleyer, Brandon, Miss	50 S.
8	Captain Neely, Accomacc Court-House, Va	50 L.
8	do	50 S.
14	W. L. White, Anacostia, D. C	20 L.
22	George W. Riggs, Washington, D. C	20 L.
24	J. T. Watson, Clinton, N. Y	200 S.
28	T. B. Coursey, Frederick, Del	20 S.
28	Herr Buckman, Lancaster, Pa	20 S.
28	L. Triplitt, jr., Mount Jackson, Va	20 S.
31	John J. Woodroof, Lynchburg, Va	20 S.
31	S. L. Gardiner, Sag Harbor, N. Y	20 S.
Apr. 1	P. T. Bartlett, Flemington, W. Va	20 S.
4	John H. Wise, Accomac Court-House, Va	50 S.
7	H. G. Otis, Clifton Station, Va	40 S.
12	Hon. Lewis Beach, Cornwall, N. Y	25 S.
14	James R. Kemper, Fishersville, Va	25 S.
14	New York Fish Commission	50 S.
16	James H. Green, Culpeper, Va	50 S.
18	W. M. Hughes, Armstrong, Mo	20 S.
18	T. H. Henderson, Macon, Ga	25 S.
18	L. Z. Rogers, Waterville, Minn	25 S.
18	W. O. Yager, Luray, Va	50 S.
18	Dr. William L. Hudson, Luray, Va	30 S.
18	Dr. Walker, Roanoke, Mo	20 S.
18	West Virginia Fish Commission	400 S.
19	Robert M. Stabler, Spencerville, Md	25 S.
20	P. Fatcher, Winchester, Va	20 S.
20	E. M. Gresham, Carlton's Store, Va	25 S.
20	George Nelson, Du Bois, Pa	25 S.
21	C. Earrman, Harrisonburg, W. Va	60 S.
21	Newton N. Reese, Leroy, Ohio	25 S.
21	Seth G. Bigelow, Silver Lake, Ind	20 S.
22	E. Merill, Lowville, N. Y	12 L.
22	Emanuel H. Jones, Fairfax Court-House, Va	20 S.
25	Abel A. Wright, Griffin, Ga	20 S.
25	F. A. Rockwell, Ridgefield, Conn	20 S.
25	Charles H. Harman, Charlottesville, Va	20 S.
25	Samuel Hopkins, Highlands, Md	25 S.
25	T. Benson Gubb, Shrewsbury, Pa	20 S.
25	Benjamin Ladd, Mulvane, Kans	20 S.
26	L. A. Thornburg, Dallas, N. C	20 S.
26	William Tudge, Anacostia, D. C	25 S.
28	Isaac Post, Astor, W. Va	20 S.
28	John A. Tumble, Astor, W. Va	20 S.
28	J. H. Finks, Roanoke, Mo	20 S.
28	W. M. Hughes, Armstrong, Mo	20 S.
28	Dr. Walker, Roanoke, Mo	20 S.
29	L. G. Janke, Richmond, Va	20 S.
30	William A. Young, Arlington, Va	25 S.
30	C. M. McLean, Athens, Ohio	60 S.
May 2	Captain Monneville, Towanda, Pa	25 S.
2	A. M. Van Ness, Marshall, Tex	25 S.
2	Raufman & Granger, Kearney, Nebr	25 S.
2	James Somerville, Brady's Point, Pa	20 S.
2	A. H. Gron, Washington, Pa	20 S.
2	W. W. Hulst, Beresford, Fla	20 S.
3	George W. Bell, Herndon, Va	25 S.
3	S. H. Rumbaugh, Weaver's Old Stand, Pa	25 S.
4	M. S. Klum, Sherman, Tex	20 S.
4	John A. Baker, Goshen, Ind	20 S.
4	S. H. Chandler, New Gloucester, Me	20 S.
4	T. T. Holley, Rock Mills, Ala	25 S.
5	James F. Rinker, Leesburg, Va	20 L.
6	New York Fish Commission	25 S.
7	Aug. W. Smith, Wheaton, Md	25 L.
9	J. E. M. Lordley, New York, N. Y	20 S.
9	Prof. W. D. Marsh, Philadelphia, Pa	20 S.

Carp furnished by Dr. Rud. Hessel, from the Monument lot ponds, &c.—Continued.

Date.	Name and address of person supplied.	Number and kind of carp.
1881.		
May 9	J. E. Webb, Greensborough, Ala	20 S.
9	J. H. Hart, Mentor, Ohio	20 S.
9	Johnson Palmer, Black Lick Station, Pa	20 S.
10	Mississippi Fish Commission	500 S.
11	E. T. Alexander, Moorefield, W. Va	20 L.
11	New York Fish Commission	20 L.
15	J. B. Hawxhurst, Homowack, N. Y	20 L.
15	J. D. W. Moore, Cabin John, Md	20 L.
15	R. H. Stewart, Athens, Ohio	20 L.
15	A. J. Pratt, Winchester, Va	20 L.
15	Charles B. Majer, Elizabeth, N. J	20 L.
16	C. Stinach, Athens, Ohio	40 L.
18	B. M. Hartshorn, Highlands, N. J	15 L.
18	C. W. Davenport, Cambridge, Ill	25 L.
18	J. F. Gilmore, Bell's Mill, Pa	15 L.
19	C. Clark Olds, Erie, Pa	50 L.
22	E. F. Merill, Washington, D. C	12 L.
23	H. M. Mitchell, Fowler, Ill	24 L.
23	W. G. Delashmutt, Martinsville, Ill	12 L.
June 8	John Dietrich, Plainfield, N. J	20 L.
	Total	66,165

The records of the earliest carp distribution are not so complete and accurate as might be desired, and the writer had no personal connection with it. He has gathered up from many sources whatever he could bearing upon the subject, and it is presented here in order that a serious gap may not be left uncovered. The work in its incipiency did not give promise to reach the gigantic dimensions of to-day. There was no surety that carp would be acceptable as food-fish, and it was not intended to replace other and better fish, of which there are several kinds. The Commission had no office nor clerical force except two or three men employed in Professor Baird's private residence, and it has been his aim from the start to spend as little money as possible on office machinery and to get the greatest attainable results in fish culture. Hence the difficulty at this date, four years removed from the period in question, of reporting fully thereon. The following table is intended as a consolidation of all attainable data regarding the distribution of carp reared in 1879 and 1880. Reports of the results attained will appear next year.

Table showing by States the final destination, so far as obtainable, of the carp distributed by the United States Fish Commission from the crops of 1879 *and* 1880.

ALABAMA.

Serial number.	Application filed.		Name.	Locality.		Delivery of carp.	
	Date.	Number.		Post-office.	County.	Date.	Number.
1	Feb. 12, 1880	1288	Henry D. Clayton	Clayton	Barbour	——, 1880	......
2	Jan. 22, 1881	3435	...do	...do	...do	Jan. 13, 1881	20
3	Feb. 9, 1880	1268	J. G. Guice	Eufaula	...do	Nov. 23, 1880	20
4	Aug. 21, 1880	2212	H. I. Irly	...do	...do	Nov. 23, 1880	20
5	Apr. 26, 1880	1887	James T. Kendall	...do	...do	——, 1880	20
6	July 31, 1879	839	W. N. Reeves	...do	...do	——, 1879	210
7	July 31, 1879	839	...do	...do	...do	Dec. 23, 1880	20
8	Feb. —, 1881	3587	P. H. Coleman	Union Springs	Bullock	Jan. 15, 1881	20
9	June 1, 1880	2033	...do	...do	...do	Aug. 15, 1881	20

Table showing by States the final destination of carp distributed, &c.—Continued.

ALABAMA—Continued.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
10	Feb. 15, 1879	647	Thomas W. Francis	Jacksonville	Calhoun	—— —, 1879	20
11	July 3, 1880	2112	J. M. Falkner	Mount'n Creek	Chilton	—— —, 1880	25
12	Apr. 10, 1880	1707	H. J. Brooks	Verbena	do	Dec. 23, 1880	20
13	Feb. 11, 1880	1383	Sanford B. Strout	Evergreen	Conecuh	—— —, 1880	......
14	Feb. 26, 1880	1358	William J. Dunn	Sepulga	do	Jan. 11, 1881	20
15	Jan. 20, 1880	1166	August Koopman	Cullman	Cullman	Dec. —, 1880	......
16	Apr. 14, 1880	1703	J. C. Holman	Ozark	Dale	Jan. 6, 1881	20
17	Mar. 10, 1881	3860	William A. Gardner	Selma	Dallas	Apr. 12, 1881	......
18	Apr. 1, 1881	3937	do	do	do	Apr. 12, 1881	......
19	Apr. 2, 1880	1645	C. Heinz	do	do	Dec. 27, 1880	20
20	Jan. 24, 1877	78	R. B. Dunlap	Boligee	Greene	—— —, 1879	20
21	June 24, 1878	357	G. B. Mobley	Eutaw	do	—— —, 1879	20
22	Mar. 1, 1881	3735	J. E. Webb	Greensboro'	Hale	May 9, 1881	......
23	Aug. 28, 1879	847	W. J. Ewbank	Birmingham	Jefferson	—— —, 1880	......
24	Dec. 22, 1880	3254	William Gessner	do	do	Dec. 22, 1880	250
25	Nov. 12, 1880	5417	B. F. Jones	do	do	Dec. 18, 1880	......
26	July 16 1878	386	S. K. Cromwell	Athens	Limestone	Dec. 15, 1880	......
27	Mar. 16, 1880	1596	G. H. Gibson	Morganville	Lowndes	Dec. 17, 1880	......
28	May 15, 1878	268	W. B. Arbery & Co	Notasulga	Macon	—— —, 1879	20
29	Apr. 6, 1880	775	Eugene McCaa	Linden	Marengo	Dec. 18, 1880	......
30	Mar. 7, 1880	960	D. Beaudequin	Spring Hill	Mobile	Nov. 15, 1879	20
31	Mar. 7, 1880	960	do	do	do	Nov. 27, 1879	40
32	ar. 25, 1880	1525	Morgan S. Gilmer	Mathews	Montgomery	Nov. —, 1880	20
33	Mar. 11, 1880	1451	Milo Barrett	Montgomery	do	Dec. 23, 1880	20
34	Mar. 10, 1880	1446	H. M. Bush	do	do	Dec. 20, 1880	21
35	Dec. 17, 1880	3078	Jerome Clanton	do	do	Dec. 30, 1880	......
36	Dec. 21, 1880	3252	T. S. Doron	do	do	Dec. 21, 1880	650
37	Aug. 6, 1878	404	James T. Greene	do	do	—— —, 1879	20
38	Mar. 29, 1880	1537	J. W. Hughes	do	do	Dec. 22, 1880	21
39	Nov. 20, 1880	5137	S. D. Seelye	do	do	Nov. —, 1880	12
40	Mar. 10, 1880	301	J. J. Shaver	Pine Level	do	Nov. 15, 1879	20
41	June 11, 1878	571	John A. Lile	Trinity Station	Morgan	Dec. 18, 1880	135
42	Oct. 26, 1880	2459	Mrs. Sallie E. Peck	do	do	Dec. 17, 1880	......
43	Mar. 3, 1880	1496	E. B. Wilkenson	Troy	Pike	Dec. 1, 1880	......
44	June 10, 1880	2063	Benjamin W. Hunt	Eatonton	Putnam	Nov. 10, 1881	150
45	Mar. 3, 1881	3800	T. T. Holley	Rock Mills	Randolph	May 4, 1881	25
46	Apr. 1, 1880	2115½	Dr. J. F. Allison	Curl's Station	Sumter	Dec. 18, 1880	......
47	Apr. 1, 1880	2115	O. Wylie	do	do	Dec. 18, 1880	......
48	Nov. 25, 1879	984	A. G. Barnes	Gainsville	do	Jan. 9, 1881	25
49	Mar. 24, 1879	712	Marcus Parker	York Station	do	Nov. 26, 1879	20
50	Dec. 13, 1880	5418	Jarrett Thompson	Talladega	Talladega	Dec. 18, 1880	......
51	Apr. 5, 1880	1686	Dabney Palmer	Snow Hill	Wilcox	Dec. 29, 1880	20

ARKANSAS.

52	Sept. 15, 1879	910	N. B. Pearce	Osage Mills	Benton	—— —, 1880	......
53	May 1, 1879	751	Jesse Turner	Van Buren	Crawford	Nov. 8, 1880	......
54	Apr. 1, 1880	1695	John A. Hudgens	Hot Springs	Garland	Nov. 8, 1880	......

CALIFORNIA.

55	....	......	R. R. Thompson	Alameda	Alameda	Dec. —, 1879	228
56	....	......	....	Sacramento	Sacramento	Dec. —, 1879	60
57	....	......	Navy Yard	Vallejo	Solano	Dec. —, 1879	12

COLORADO.

58	Dec. 10, 1879	2602	James Archer	Denver	Arapahoe	Dec. 10, 1879	60
59	Dec. 9, 1879	2595	Addison Baker	do	do	Dec. 9, 1879	15
60	....	......	N. A. Baker	do	do	Dec. —, 1879	15
61	Nov. 15, 1880	2779	J. M. Broadwell	do	do	Nov. 15, 1880	5
62	Feb. 15, 1880	2669	do	do	do	Feb. 15, 1880	10
63	Dec. 8, 1879	2589	L. L. Higgins	do	do	Dec. 8, 1879	15
64	Dec. 9, 1879	2593	Henry Lee	do	do	Dec. 9, 1879	15
65	Oct. 1, 1880	2683	J. Loomis	do	do	Oct. 1, 1880	8
66	Dec. 9, 1879	2594	L. H. Perrin	do	do	Dec. 9, 1879	15
67	Sept. 27, 1879	911	H. M. Teller	do	do	—— —, 1879	500
68	....	......	do	do	do	Feb. —, 1880	21

Table showing by States the final destination of carp distributed, &c.—Continued.

COLORADO—Continued.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
69	Oct. 1, 1880	2685	G. F. Wortman	Denver	Arapahoe	Oct. 1, 1880	8
70	Dec. 12, 1879	2613	C. M. Tyler	Boulder	Boulder	Dec. 12, 1879	21
71	Feb. 18, 1880	2671	L. C. Mead	Longmont	...do	Feb. 18, 1880	15
72	Feb. 17, 1880	2670	William A. Davidson.	Valmont	...do	Feb. 17, 1880	20
73	Sept. 23, 1878	447	W. E. Sisty	Brookvale	Clear Creek	—— —, 1879	500
74	July 2, 1878	403	...do	...do	...do	Dec. 10, 1879	217
75	July 2, 1878	403	...do	...do	...do	May, 1880	250
76	July 2, 1878	403	...do	...do	...do	July, 1880	226
77	Dec. 10, 1879	2601	George de la Vergne	Colorado Sp'gs.	El Paso	Dec. 10, 1879	60
78	Dec. 10, 1879	2598	Peter Fischer	Morrison	Jefferson	Dec. 10, 1879	15
79	Dec. 10, 1879	2604	G. W. Harriman	...do	...do	Dec. 10, 1879	15
80	Oct. 1, 1880	2684	A. Kroning	...do	...do	Oct. 1, 1880	8
81	Dec. 10, 1879	2600	A. Rooney	...do	...do	Dec. 10, 1879	15
82	Feb. 20, 1880	1377	W. R. Scott	...do	...do	Oct. 8, 1880	8
83	Nov. 30, 1878	563	Hermann Hibschle	Leadville	Lake	Oct. 1, 1880	9
84	Dec. 10, 1879	2599	C. C. Harely	Fort Collins	Larimer	Dec. 10, 1879	15
85	Dec. 10, 1879	2603	John Sheldon	...do	...do	Dec. 10, 1879	15
86	Jan. 27, 1880	1260	Charles Warren	...do	...do	—— —, 1880	......
87	Oct. 1, 1880	2682	J. Hengstler	Loveland	...do	Oct. 1, 1880	8
88	Apr. 26, 1880	1799	Russell and Macomber	Stonewall	Las Animas	—— —, 1880	......
89	Dec. 6, 1879	2588	J. K. Brewster	South Pueblo	Pueblo	Dec. 6, 1879	15
90	Jan. 1, 1880	2637	B. H. Eaton	Greeley	Weld	Jan. 1, 1880	20

CONNECTICUT.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
91	Dec. —, 1880	5201	O. D. Taylor	New Fairfield.	Danbury	Dec. —, 1880	15
92	May 19, 1881	4506	B. E. Cowperthwait	Danbury	Fairfield	—— —, 1880	......
93	Apr. —, 1881	4218	Amos Stone	...do	...do	—— —, 1880	20
94	Dec. 3, 1880	3183	E. Gilbert	Georgetown	...do	Dec. 3, 1880	10
95	Dec. 3, 1880	3183	...do	...do	...do	Jan. 4, 1881	20
96	Dec. —, 1880	5206	E. O. Hurlbutt	...do	...do	Dec. —, 1880	20
97	Dec. 22, 1880	3255	Samuel J. Miller	...do	...do	Dec. 22, 1880	20
98	Dec. 24, 1880	3258	Aaron Osborn	...do	...do	Dec. 24, 1880	20
99	Dec. —, 1880	5205	G. T. Osborn	...do	...do	Dec. —, 1880	20
100	....	......	O. S. Starr	...do	...do	Dec. —, 1880	20
101	Oct. 11, 1880	2397	Joseph M. Bassett	Long Hill	...do	Nov. 15, 1880	20
102	Dec. 10, 1880	3213	J. L. Hunt	Ridgefield	...do	Dec. 10, 1880	20
103	Jan. 20, 1880	1154	F. A. Rockwell	...do	...do	Nov. 26, 1880	......
104	Mar. —, 1881	4220	...do	...do	...do	Mar. —, 1881	......
105	May 11, 1880	1929	John B. Knapp	Stamford	...do	Nov. 16, 1880	20
106	Aug. 1, 1880	2193	J. Meads Warren	...do	...do	Nov. 16, 1880	20
107	May 10, 1880	1918	William T. Curtis	Stratford	...do	Nov. 6, 1880	20
108	Feb. 4, 1881	3058	D. C. Birdsall	Westport	...do	Feb. 4, 1881	20
109	Dec. —, 1880	5209	S. H. Carrington	Bristol	Hartford	Dec. —, 1880	20
110	Dec. —, 1880	5199	C. O. Penfield	...do	...do	Nov. —, 1880	20
111	Apr. 19, 1880	1811	Wm. G. Comstock	East Hartford	...do	Nov. —, 1880	20
112	Sept. 27, 1880	2379	Miss Sarah Porter	Farmington	...do	Nov. 9, 1880	20
113	Dec. —, 1880	5200	Alvin Taplin	Forestville	...do	Dec. —, 1880	15
114	Dec. 23, 1881	9567	H. C. Judd	Hartford	...do	Nov. —, 1880	20
115	Nov. —, 1880	3282	Gurdon W. Russell	...do	...do	Nov. —, 1880	10
116	Nov. —, 1880	3283	H. P. Stearns	...do	...do	Nov. —, 1880	15
117	Apr. 24, 1880	1885	Henry A. Slater	North Manchester.	...do	Nov. —, 1880	20
118	Mar. 30, 1880	1669	James N. Bishop	Plainville	...do	Oct. 26, 1880	......
119	Nov. 12, 1880	3285	Lucius P. Clark	Poquonock	...do	Nov. 12, 1880	20
120	Nov. 16, 1880	3286	Mrs. Fred'k Fenton	...do	...do	Nov. 16, 1880	30
121	Oct. 28, 1880	2691	Henry J. Fenton	...do	...do	Jan. 1, 1881	35
122	Jan. 12, 1881	9557	A. C. Huntington	...do	...do	Dec. —, 1880	20
123	Dec. 23, 1881	7711	S. D. Drake	Windsor	...do	—— —, 1881	......
124	....	......	Henry J. Fenton	...do	...do	Dec. 6, 1880	20
125	Dec. —, 1880	5208	H. G. Phelps	...do	...do	Nov. —, 1880	20
126	May 24, 1880	2001	Caleb Leavitt	Windsorville	...do	Nov. 5, 1880	30
127	Apr. 1, 1880	1629	George H. Comstock	Centre Brook	Middlesex	Nov. 9, 1880	20
128	Dec. —, 1880	5204	C. Hurd	Mid. Haddam	...do	Dec. —, 1880	15
129	Nov. 5, 1880	3280	Arthur H. Worthington.	...do	...do	Nov. 5, 1880	20
130	Apr. 22, 1880	1747	R. G. Pike	Middletown	...do	Oct. 26, 1880	......
131	Jan. 29, 1881	3408	Charles H. Emily	Moodus	...do	Feb. 1, 1881	25
132	Apr. 28, 1880	1819	D. F. White	Derby	New Haven	Nov. 10, 1880	10
133	Nov. 26, 1880	3288	L. G. Potter	Meriden	...do	Nov. 26, 1880	20
134	Sept. 18, 1880	2344	James Gallagher, jr	New Haven	...do	Nov. 12, 1880	30
135	Apr. 10, 1880	1649	Harvey S. Hall	Wallingford	...do	Nov. 6, 1880	20
136	Sept. 27, 1880	2380	Leonard V. Greene	Norwich	New London	Nov. 16, 1880	20

Table showing by States the final destination of carp distributed, &c.—Continued.

CONNECTICUT—Continued.

Serial number.	Application filed.		Name.	Locality.		Delivery of carp.	
	Date.	Number.		Post-office.	County.	Date.	Number.
137	Apr. 3, 1880	1648	Charles H. Babcock	Eagleville	Tolland	Oct. 26, 1880	......
138	Nov. 8, 1880	2722	Thomas S. Cummings	Mansfield Centre.	...do	Nov. 8, 1880	......
139	Feb. —, 1880	1213	W. S. Eaton	...do	...do	Nov. 25, 1880	30
140	Feb. 23, 1880	1373	James Myles	...do	...do	Nov. 26, 1880	......
141	Nov. 12, 1880	3284	Lucius Tucker	Pomfret	Windham	Nov. 12, 1880	20
142	Apr. 8, 1880	1619	Alex. H. Vinton	...do	...do	Nov. 9, 1880	10
143	Dec. —, 1880	5207	A. H. Vierton	...do	...do	Dec. —, 1880	10
144	Apr. 1, 1880	1654	W. I. Bartholomew	Putnam	...do	Oct. 26, 1880	......
145	......	......	L. Tucker	...do	...do	Nov. 4, 1880	20
			DAKOTA.				
146	Apr. —, 1881	4337	Mrs. Carrie Kirk	Elk Point	Union	Mar. —, 1881	20
147	May 27, 1878	314	J. E. West	Yankton	Yankton	Nov. 11, 1880	50
			DELAWARE.				
148	Dec. 20, 1879	2627	Eli Saulsbury	Dover	Kent	Dec. 20, 1879	275
149	Dec. 20, 1879	2627	...do	...do	...do	Nov. 23, 1880	184
150	Dec. 20, 1879	2629	Z. Hopkins	Farmington	...do	Dec. 20, 1879	50
151	......	......	T. B. Coursey	Frederica	...do	Mar. 28, 1881	20
152	May 18, 1880	1940	J. W. Cansey	Milford	...do	Dec. 16, 1880	40
153	Apr. 10, 1880 Nov. 22, 1880	1610 2871	J. Wilson Cooch	Cooch's Bridge	New Castle	Nov. 22, 1880	20
154	July 26, 1880	2185	William Jinks Fell	Faulkland	...do	Nov. 23, 1880	20
155	May 13, 1880	1941	Charles A. Linn	Kirkwood	...do	—— —, 1880	20
156	Nov. 23, 1880	2887	C. A. Lum	Middletown	...do	Nov. 23, 1880	20
157	Mar. —, 1879	697	Samuel Townsend	Townsend	...do	—— —, 1879	50
158	Jan. 17, 1880	1113	S. N. Pusey	Wilmington	...do	Nov. 23, 1880	......
159	Apr. 3, 1880	1674	C. A. Rodney	...do	...do	Nov. 23, 1880	20
160	——, —, 1881	9655	Dr. E. G. Shortlidge	...do	...do	Nov. 11, 1880	100
161	May 25, 1880	2009	Samuel N. Trump	...do	...do	Nov. 23, 1880	20
162	Nov. 12, 1880	2468	J. & G. M Outten	Concord	Sussex	Apr. 20, 1881	20
163	Apr. 2, 1880	1675	R. A. Rosenbaum	Georgetown	...do	Nov. —, 1880	......
164	Mar. 5, 1880	1488	George W. Horsey	Laurel	...do	Jan. 7, 1881	20
165	Mar. 31, 1880	1566	Thomas W. Ralph	...do	...do	Nov. —, 1880	......
166	Mar. 30, 1880	1603	George De Orton	Lewes	...do	Nov. 22, 1880	......
167	Apr. 24, 1880	1886	E. W. Tunnell	...do	...do	Nov. —, 1880	......
168	Apr. 6, 1880	1672	James A. Hopkins	Milton	...do	Nov. —, 1880	......
169	May 29, 1880	2022	David E. Wolfe	...do	...do	Nov. 22, 1880	......
170	......	......	John N. Wright	Oak Grove	...do	Dec. 4, 1879	70
171	Dec. 5, 1879	2585	...do	...do	...do	Dec. 5, 1879	20
172	Dec. 20, 1879	2630	J. P. Delaney	Seaford	...do	Dec. 20, 1879	225
			DISTRICT OF COLUMBIA.				
173	Apr. 25, 1881	4079	William Tudge	......	Anacostia	Apr. 26, 1881	25
174	Mar. 8, 1881	1502	W. L. White	......	...do	Mar. 14, 1881	20
175	......	......	W. M. Curtis	......	Georgetown	Nov. 20, 1880	20
176	Aug. 11, 1877	98	Admiral Ammen	......	Washington	—— —, 1879	......
177	May 17, 1880	1956	E. C. Dean	20th & B'dry st.	...do	—— —, 1880	......
178	Dec. 18, 1879	2625	M. O. Dolpees	......	...do	Dec. 18, 1879	44
179	Apr. 9, 1880	1612½	Henry C. Hallowell	Box 361	...do	Nov. 16, 1880	50
180	May 27, 1880	2013	John Herrell	519 3d street	...do	May 31, 1880	20
181	May 18, 1880	2674	Elliott Jones	U. S. arsenal	...do	May 20, 1880	5
182	......	......	E. F. Merill	......	...do	May 22, 1881	12
183	Apr. 9, 1880	1612	Francis Miller	Post-office	...do	Nov. 16, 1880	50
184	Apr. 9, 1880	1673	H. B. Parker	...do	...do	Nov. 6, 1880	......
185	May 11, 1880	1932	D. W. Prentiss	1224 9th street	...do	—— —, 1880	......
186	June 5, 1880	2044	George W. Riggs	1617 I street	...do	—— —, 1880	......
187	......	......	...do	...do	...do	Mar. 22, 1881	20
188	May 10, 1880	1927	W. B. Shaw	Treas'y Dept.	...do	—— —, 1880	......
189	Oct. 25, 1879	945	W. H. H. Smith	Navy Dept	...do	—— —, 1879	16
190	July 2, 1879	824	William A. Wallace	......	...do	Oct. 28, 1879	25
191	July 2, 1879	824	...do	......	...do	July 2, 1880	36
192	May 19, 1880	1972	Charles White	462 Maine ave.	...do	Jan. 10, 1881	25

Table showing by States the final destination of carp distributed, &c.—Continued.

FLORIDA.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
193	May 15, 1880	1952	C. J. Kenworthy	Jacksonville	Duval	Jan. 15, 1881	......
194	Aug. 20, 1880	2232	G. W. Lyons	Monticello	Jefferson	Feb. 1, 1881	80
195	Feb. —, 1881	3501	John A. Henderson	Tallahassee	Leon	Feb. 1, 1881	30
196	Sept. 1, 1880	2240	David Graham	Bronson	Levy	Feb. 5, 1881	20
197	Mar. 14, 1880	1872	D. H. Carn	Flemington	Marion	Jan. 15, 1881	......
198	July 3, 1880	2144	R. T. P. Allen	Osceola	Orange	Jan. 15, 1881	......
199	Mar. 15, 1881	1533	J. L. Brewster	Oviedo	....do	Jan. 15, 1881	......
200	Jan. 4, 1881	3542	J. N. Bishop	Sanford	....do	Jan. 4, 1881	10
201	Jan. 31, 1880	1151	O. O. Smith	....do	....do	Jan. 19, 1881	20
202	Nov, 24, 1880	5419	Joseph Hicks	Mount Royal	Putnam	Jan. 15, 1881	......
203	Mar. 15, 1880	1579	Alexander Ray	....do	....do	Jan. 15, 1881	......
204	July 19, 1880	2175	Walter Thomas	Norwalk	....do	Jan. 15, 1881	......
205	Jan. 4, 1879	533	Henry Neville	Saratoga	....do	Jan. 15, 1881	......
206	Nov. 17, 1879	977	George C. Rixford	Rixford	Suwannee	—— —, 1879	77
207	....	......	W. W. Hulst	Beresford	Volusia	May 2, 1881	20
208	Apr. 10, 1880	1719	A. T. Rossetter	De Land	....do	Jan. 15, 1881	....
209	Apr. 2, 1880	1621	I. B. Wood	....do	....do	Jan. 15, 1881	23
210	Mar. 16, 1880	1578	A. Cosner	Orange City	....do	Jan. 15, 1881	......

GEORGIA.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
211	Nov. 19, 1880	2852	H. E. McComb	Milledgeville	Baldwin	Nov. 19, 1880	20
212	Aug. 13, 1878	388	G. C. McKinley	....do	....do	Nov. —, 1880	20
213	....	......	Walter Paine	....do	....do	Nov. 18, 1880	20
214	Nov. 20, 1880	2854	....do	....do	....do	Jan. 20, 1881	112
215	Nov. 20, 1880	2854	....do	....do	....do	Jan. 21, 1881	60
216	Nov. 20, 1880	2854	....do	....do	....do	Feb. 9, 1881	100
217	May 20, 1878	274	J. W. Aderhold	Macon	Bibb	—— —, 1879	16
218	May 20, 1878	274	....do	....do	....do	—— —, 1880	30
219	May 6, 1878	247	J. H. Blount	....do	....do	—— —, 1879	500
220	May 25, 1878	273	William Brantley	....do	....do	—— —, 1879	16
221	May 25, 1878	273	....do	....do	....do	Jan. 20, 1880	40
222	Apr. 25, 1882	13348	William S. Brantley	....do	....do	—— —, 1880	......
223	Nov. 19, 1880	2839	Frank Cannon	....do	....do	Nov. 19, 1880	20
224	....	......	W. B. Chapman	....do	....do	Jan. 19, 1881	40
225	Nov. 19, 1880	2843	E. D. Cherry	....do	....do	Nov. 19, 1880	6
226	Nov. 19, 1880	2843	....do	....do	....do	Jan. 20, 1881	20
227	Nov. 20, 1880	2858	E. J. Davis	....do	....do	Nov. 20, 1881	20
228	Jan. 13, 1880	2652	E. M. Davis	....do	....do	Jan. 13, 1880	15
229	Dec. —, 1880	5232	H. A. Dunwardy	....do	....do	Dec. —, 1880	16
230	Dec. —, 1880	5231	P. W. Edge	....do	....do	Dec. —, 1880	20
231	Nov. 19, 1880	2842	Harry S. Edwards	....do	....do	Nov. 19, 1880	8
232	Nov. 19, 1880	2842	....do	....do	....do	Dec. 31, 1880	15
233	Nov. 20, 1880	2857	M. Ellis	....do	....do	Nov. 20, 1880	20
234	Jan. 13, 1880	2653	A. W. Gibson	....do	....do	Jan. 13, 4880	175
235	Dec. —, 1880	5230	S. Greenwood	....do	....do	Dec. 10, 1880	16
236	Jan. 8, 1880	1232	Samuel I. Gustin	....do	....do	Dec. 3, 1880	30
237	Nov. 19, 1880	2841	J. F. Hanson	....do	....do	Nov. 19, 1880	20
238	Jan. 5, 1880	1159	C. J. Harris	....do	....do	Nov. 19, 1880	20
239	Nov. 19, 1880	2844	Joseph A. Harrison	....do	....do	Nov. 19, 1880	5
240	Nov. 19, 1880	2844	....do	....do	....do	Dec. 1, 1880	20
241	Apr. 15, 1881	4064	T. H. Henderson	....do	....do	Apr. 18, 1881	25
242	Jan. 13, 1880	2654	C. Herbst	....do	....do	Jan. 13, 1880	15
243	Jan. 13, 1880	2654	....do	....do	....do	Jan. —, 1881	10
244	Nov. 19, 1880	2847	J. H. Hertz	....do	....do	Nov. 19, 1880	20
245	Dec. —, 1880	5227	J. C. Hant	....do	....do	Dec. —, 1880	60
246	Dec. —, 1880	5233	E. Isaacs	....do	....do	Dec. —, 1880	20
247	Nov. 19, 1880	2837	W. B. Johnston	....do	....do	Nov. 19, 1880	20
248	Jan. 13, 1880	2658	Anthony Krentz	....do	....do	Jan. 13, 1880	16
249	Jan. 13, 1880	2658	....do	....do	....do	Jan. 20, 1881	50
250	Nov. 19, 1880	2846	H. J. Lamar	....do	....do	Nov. 19, 1880	20
251	Nov. 19, 1880	2846	....do	....do	....do	Dec. —, 1880	30
252	Nov. 19, 1880	2838	B. D. Lumsden	....do	....do	Nov. 19, 1880	20
253	Nov. 19, 1880	2850	A. A. Menard	....do	....do	Nov. 19, 1880	20
254	Nov. 19, 1880	2850	....do	....do	....do	Dec. —, 1880	30
255	Nov. 19, 1880	2840	L. Merkel	....do	....do	Nov. 19, 1880	20
256	Dec. —, 1880	5226	Henry Pellew	....do	....do	Dec. —, 1880	20
257	Jan. 13, 1880	2655	Ernest Perchtee	....do	....do	Jan. 13, 1880	10
258	Dec. 13, 1879	1014	H. J. Peter	....do	....do	—— —, 1879	30
259	Dec. 13, 1879	1014	....do	....do	....do	Jan. 20, 1880	90
260	Mar. —, 1877	59	J. C. Plant	....do	....do	Nov. 7, 1879	16
261	Mar. —, 1877	59	....do	....do	....do	Nov. 10, 1879	15
262	Mar. —, 1877	59	....do	....do	....do	Jan. 13, 1880	32

Table showing by States the final destination of carp distributed, &c.—Continued.

GEORGIA—Continued.

Serial number.	APPLICATION FILED.		Name.	LOCALITY.		DELIVERY OF CARP.	
	Date.	Number.		Post-office.	County.	Date.	Number.
263	Mar. —, 1877	59	J. C. Plant	Macon	Bibb	Nov. 19, 1880	20
264	Mar. —, 1877	59	....do	....do	....do	Nov. 22, 1880	2
265	Jan. 13, 1880	2651	James R. Rice	....do	....do	Jan. 13, 1880	15
266	Dec. —, 1880	5228	E. T. Rogers	....do	....do	Dec. —, 1880	20
267	Nov. 19, 1880	2845	M. R. Rogers	....do	....do	Nov. 19, 1880	25
268	Nov. 19, 1880	2845	....do	....do	....do	Jan. 20, 1881	20
269	Nov. 19, 1880	2845	....do	....do	....do	Dec. —, 1880	60
270	Dec. —, 1880	5229	W. C. Timberlak	....do	....do	Dec. —, 1880	30
271	Nov. 19, 1880	2848	George B. Turpin	....do	....do	Nov. 19, 1880	20
272	Jan. 13, 1880	2659	W. C. Singleton	....do	....do	Jan. 13, 1880	13
273	Jan. 13, 1880	2659	....do	....do	....do	Nov. 19, 1880	20
274	Jan. 13, 1880	2659	....do	....do	....do	Jan. 20, 1881	20
275	Jan. 13, 1880	2656	S. M. Subers	....do	....do	Jan. 13, 1880	14
276	Jan. 13, 1880	2656	....do	....do	....do	Nov. 19, 1880	20
277	Jan. 13, 1880	2656	....do	....do	....do	Jan. 20, 1880	20
278	Jan. 13, 1880	2660	John Wise	....do	....do	Jan. 13, 1880	15
279	Nov. 19, 1880	2849	E. Withowski	....do	....do	Nov. 19, 1880	20
280	Nov. 19, 1880	2849	....do	....do	....do	Jan. 20, 1881	50
281	Nov. 19, 1880	2849	....do	....do	....do	Dec. —, 1880	60
282	Jan. 13, 1880	2657	D. S. Wright	....do	....do	Jan. 13, 1880	5
383	Aug. 9, 1880	2203	John A. Irvine	Quitman	Brooks	Jan. 29, 1881	20
284	Nov. 24, 1880	3363	Thomas J. Livingston	....do	....do	Jan. 29, 1881	39
285	Nov. 20, 1879	2531	S. P. Christopher	Fairburn	Campbell	Nov. 20, 1879	6
286	Feb. 7, 1881	3564	Oscar Reese	Carrollton	Carroll	Jan. 31, 1881	......
287	Dec. 7, 1879	996	William Williams	Villa Rica	....do	Nov. 10, 1880	......
288	Nov. 26, 1879	2555	Wm. N. Habersham	Savanah	Chatham	Nov. 26, 1879	25
289	Nov. 19, 1879	2521	E. L. Jones	Hopeville	Clayton	Nov. 19, 1879	12
290	Mar. 29, 1880	1539	David J. Sirmans, sr.	Du Pont	Clinch	Nov. 10, 1880	......
291	Mar. 9, 1880	1441	Jonathan T. Morgan	Homerville	....do	Nov. 10, 1880	......
292	Nov. 21, 1879	2537	W. T. Winn	Marietta	Cobb	Nov 21, 1879	12
293	July 1, 1880	2134	Isaac N. Moon	Powder Sp'gs.	....do	Nov. 27, 1880	8
294	July 29, 1878	402	A. B. Hanna	Smith	Dade	Nov. 10, 1880	......
295	Nov. 21, 1879	2538	A. F. Phorr	Decatur	De Kalb	Nov. 21, 1879	12
296	Apr. 12, 1878	221	W. E. Smith	Albany	Dougherty	Nov. —, 1879	60
297	July 3, 1880	2142	James H. Edinfield	Swainsboro'	Emanuel	Nov. 10, 1880	......
298	Mar. 3, 1880	1604	Joshua R. Rountree	....do	....do	Nov. 10, 1880	......
299	Mar. 11, 1880	1440	A. L. Sutton	....do	....do	Nov. 11, 1880	......
300	Mar. 16, 1878	202	E. C. McAffee	Cumming	Forsyth	—— —, 1879	16
301	Nov. 18, 1879	2508	N. S. Angier	Atlanta	Fulton	Nov. 18, 1879	12
302	May 15, 1879	764	Henry Banks	....do	....do	Nov. 10, 1880	......
303	Nov. 20, 1879	2527	Jerome Pearse	....do	....do	Nov. 20, 1879	12
304	Nov. 18, 1879	2506	Milton A. Caneller	....do	....do	Nov. 18, 1879	12
305	Nov. 20, 1879	2528	George W. Coltier	....do	....do	Nov. 20, 1879	20
306	Nov. 19, 1879	2519	Samuel Hape	....do	....do	Nov. 19, 1879	12
307	Oct. —, 1879	961	J. T. Henderson	....do	....do	—— —, 1879	242
308	Nov. 18, 1879	2507	W. A. Jett	....do	....do	Nov. 18, 1879	12
309	Nov. 22, 1879	2547	E. B. Plunket	....do	....do	Nov. 22, 1879	6
310	Feb. 10, 1880	1323	James A. McCool	....do	....do	Nov. 8, 1880	6
311	Feb. 10, 1880	1323	....do	....do	....do	Jan. 19, 1881	25
312	Nov. 17, 1881	2526	W. Pair	....do	....do	Nov. 29, 1879	6
313	Nov. 19, 1879	2518	M. E. Thornton	....do	....do	Nov. 19, 1879	12
314	Nov. 18, 1879	2509	B. J. Wilson	....do	....do	Nov. 18, 1879	36
315	Nov. 21, 1879	2536	H. Sommerrone	Duluth	Gwinnett	Nov. 21, 1879	6
316	Dec. 1, 1879	997	David Dickson	Culverton	Hancock	Nov. 10, 1880	......
317	Mar. 26, 1879	725	P. T. Pendleton	Sparta	....do	Nov. 10, 1880	......
318	June 11, 1880	2064	Alfred M. Ayers	Hartwell	Hart	Nov. 10, 1880	......
319	May 31, 1880	2026	A. J. Mathews	....do	....do	Nov. 10, 1880	......
320	Nov. 20, 1880	2856	W. W. Wagnon	Byron	Houston	Nov. 20, 1880	20
321	June 15, 1878	338	E. C. David	Harm'ny Gr've	Jackson	—— —, 1879	10
322	Sept. 2, 1880	2369	Jesse White	....do	....do	Nov. 17, 1880	16
323	Mar. 27, 1880	1558	J. G. Justice	Marcus	....do	Nov. 20, 1880	8
324	May 25, 1878	275	A. S. Hamilton	Clinton	Jones	—— —, 1879	16
325	May 25, 1878	275	....do	....do	....do	Nov. 20, 1880	20
326	May 25, 1878	276	B. F. Ross	Haddock Sta'n	....do	Nov. 8, 1879	14
327	May 25, 1878	276	....do	....do	....do	Jan. —, 1881	60
328	Sept. 10, 1880	2741	T. J. Palin	Valdosta	Lowndes	Dec. 17, 1880	......
329	Dec. 29, 1879	1040	S. L. Varedoo	....do	....do	Jan. 29, 1881	20
330	Jan. 31, 1881	3487	D. J. Frederick	Marshallsville	Macon	Feb. 11, 1881	25
331	Dec. —, 1880	2900	E. J. Frederick	....do	....do	—— —, 1880	......
332	Jan. 31, 1881	3488	Marshall J. Hatcher	....do	....do	Feb. 11, 1881	150
333	May 10, 1880	1928	G. H. Slappey	....do	....do	Dec. —, 1880	20
334	Dec. —, 1880	5219	A. T. Holt	Bolingbroke	Monroe	Dec. —, 1880	20
335	Nov. 20, 1879	2529	Thomas B. Cabaniss	Forsyth	....do	Nov. 20, 1879	20
336	July 27, 1880	2187	William Watson	....do	....do	Nov. 10, 1880	......
337	May 24, 1880	1999	N. C. Fambro	Gogganville	....do	Nov. 10, 1880	......
338	....	......	E. Heyser	Madison	Morgan	Nov. 21, 1879	22

Table showing by States the final destination of carp distributed, &c.—Continued.

GEORGIA—Continued.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
339	Nov. 19, 1880	2851	N. P. Hunt	Covington	Newton	Nov. 19, 1880	20
340	Mar. 5, 1880	1342	Josiah Perry	do	do	Nov. 19, 1880	20
341	Nov. 11, 1880	3130	H. H. Cogburn	Eatonton	Putnam	Nov. 11, 1880	20
342			R. C. Hember	do	do	Dec. —, 1880	20
343	Oct. 22, 1881	6926	Benjamin W. Hunt	do	do	Nov. 11, 1880	20
344	Dec. —, 1880	5224	A. B. Jackson	do	do	Dec. —, 1880	20
345	Nov. 20, 1880	2855	Benjamin W. Kent	do	do	Nov. 20, 1880	70
346	Oct. 22, 1881	6927	John W. Maddox	do	do	Dec. —, 1880	20
347	Nov. 13, 1880	3131	James Pearman	do	do	Nov. 13, 1880	20
348	Dec. —, 1880	5222	A. S. Reid	do	do	Dec. —, 1880	20
349	Nov. 22, 1880	2872	J. N. Hale	Conyers	Rockdale	Nov. 22, 1880	20
350	Aug. 30, 1880	2239	William L. Peek	do	do	Nov. 22, 1880	200
351	Nov. 6, 1879	962	E. W. Beck	Griffin	Spalding	Nov. 10, 1880	
352	Nov. 19, 1879	2517	Abel A. Wright	do	do	Nov. 19, 1879	39
353	Apr. 11, 1881	3944	do	do	do	Apr. —, 1881	
354	Jan. 31, 1881	3489	John A. Cobb	Americus	Sumter	Feb. 11, 1881	25
355	Jan. 27, 1881	3452	E. J. Eldridge	do	do	Feb. 11, 1881	200
356	Nov. 20, 1879	2530	J. C. Manuel	Geneva	Talbot	Nov. 20, 1879	36
357	Nov. 8, 1879	2485	J. T. Chastain	Thomasville	Thomas	Nov. 8, 1879	16
358	Jan. 17, 1878	179	Charles P. Hansell	do	do	—— —, 1879	16
359			do	do	do	Jan. 21, 1881	20
360	Sept. 8, 1880	2348	H. H. Cary	La Grange	Troup	Nov. 10, 1880	48
361			do	do	do	Jan. 29, 1881	48
362	Nov. 19, 1879	2515	B. C. Ferrell	do	do	Nov. 19, 1879	13
363	Nov. 19, 1879	2516	M. T. McLendon	do	do	Nov. 19, 1879	7
364	Nov. 19, 1879	2514	D. N. Speer	do	do	Nov. 19, 1879	19
365	Nov. 22, 1879	2546	J. H. Parnell	West Point	do	Nov. 22, 1879	10
366	May 3, 1880	1838	Thomas Y. Park	Eagle Cliff	Walker	Nov. 10, 1880	
367	Sept. 18, 1878	454	Herman Naumann	Jug Tavern	Walton	Nov. 16, 1880	
368	Dec. —, 1880	5221	H. L. Spencer	Social Circle	do	Dec. —, 1880	60
369	Mar. 11, 1880	1439	Daniel Lott	Way Cross	Ware	Nov. 10, 1880	
370	Dec. —, 1880	5220	A. W. Jackson	Sandersville	Washington	Dec. —, 1880	60
371	Nov. 4, 1880	2448	L. A. Folsom	Dalton	Whitfield	Dec. 17, 1880	
372	Nov. 13, 1880	3132	D. D. Saint	Gordon	Wilkinson	Nov. 13, 1880	20

ILLINOIS.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
373	May —, 1881	4570	H. M. Mitchell	Fowler	Adams	May —, 1881	24
374	Mar. 26, 1880	1554	Ira Coe	Quincy	do	July 8, 1880	8
375	Mar. 22, 1880	1531	Jacques Ravold, M. D.	Greenville	Bond	July 8, 1880	8
376	May 24, 1881	4613	W. G. Delashmutt	Martinsville	Clark	May —, 1881	15
377	Nov. 6, 1880	2719	E. J. Lehmann	Chicago	Cook	Nov. 6, 1880	10
378	Nov. 6, 1880	2719	do	do	do	Dec. 1, 1880	25
379	Nov. 20, 1879	993	Henry M. Kidder	N. Evanston	do	July 2, 1880	
380	Apr. 2, 1880	1684	H. Hammerschmidt	Naperville	Du Page	Nov. 25, 1881	20
381	Feb. 9, 1880	1264	Wes. Thompson, M. D	Effingham	Effingham	July 8, 1880	10
382	Jan. 18, 1881	3409	C. W. Davenport	Cambridge	Henry	May 21, 1881	42
383	June 1, 1880	2030	Daniel H. Brush	Carbondale	Jackson	Nov. 8, 1880	
384	Apr. 14, 1880	1642	Van Wilbanks	Mt. Vernon	Jefferson	July 8, 1880	8
385	Apr. 14, 1880	1642	do	do	do	Jan. 11, 1881	7
386	Aug. 17, 1880	2231	Wilson Hahn	Galesburg	Knox	Nov. 8, 1880	
387			Thomas Milner	Waukegan	Lake	Nov. 25, 1880	25
388	Apr. 30, 1880	1891	J. A. Fyffe	Sumner	Lawrence	Nov. 8, 1880	
389	May 13, 1880	1944	Peter Swisher	Amboy	Lee	Oct. 7, 1880	
390	Aug. 13, 1880	2209	Thomas Davis	Macon	Macon	Nov. 8, 1880	
391	Mar. 16, 1880	1202	George Siegel	Carlinville	Macoupin	Nov. 8, 1880	
392	Jan. 29, 1879	621	Samuel R. Thomas	Virden	do	July 8, 1880	9
393	Jan. 29, 1879	621	do	do	do	Jan. 15, 1881	15
394	Apr. 27, 1880	1889	R. R. Stanley	Long Lake	Madison	Nov. 8, 1880	
395	Jan. 21, 1880	1200	W. H. Horine, sr	Waterloo	Monroe	Jan. 11, 1881	8
396	Feb. 11, 1880	1410	Waterloo Sport'g Cl'b	do	do	June 14, 1880	8
397	July —, 1876	1	Fish Club	Belleville	Saint Clair	Oct. 28, 1879	20
398	Dec. 16, 1879	2622	H. H. Hartmanor	do	do	Dec. 16, 1879	20
399	May 15, 1880	1947	W. E. Burnett	Harrisburg	Saline	Nov. 8, 1880	
400	June 16, 1880	2124	John C. Wilson	Rushville	Schuyler	Nov. 8, 1880	
401	Feb. 10, 1881	3765	Michael Langenstein	Fount'in Creek	Stephenson	Mar. 7, 1881	30
402	July 3, 1880	2143	E. N. Clark	Cobden	Union	Nov. 20, 1880	20
403	Sept. 28, 1880	2381	Fairfield Woolen Mills	Fairfield	Wayne	Dec. 11, 1880	
404	May 26, 1880	2012	H. L. Wheat	do	do	July 8, 1880	143
405	Sept. 8, 1880	2349	John Lowe	Johnsonville	do	Nov. 26, 1880	20

Table showing by States the final destination of carp distributed, &c.—Continued.

INDIANA.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
406	Mar. 5, 1880	1492	Quartermaster's Dept.	Jeffersonville	Clark	Nov. 16, 1880	......
407	Apr. 5, 1880	1631	Cullen Bradley	Harmony	Clay	Nov. 16, 1880	......
408	Oct. 4, 1880	2384	Arthur M. Chittick	Geetingsville	Clinton	Nov. 4, 1880	......
409	Sept. 13, 1880	999	M. V. Young, M. D	do	do	Nov. 16, 1880	......
410	Dec. 2, 1880	3174	John T. Hopkins	Jefferson	do	Dec. 2, 1880	20
411	Oct. —, 1880	2689	J. N. Wallingford	Greensburg	Decatur	Jan. 11, 1881	9
412	Dec. 29, 1879	1039	John W. Bortsfield	Selma	Delaware	Jan. 14, 1881	16
413	Feb. 8, 1881	3546	G. T. Ager	Goshen	Elkhart	Feb. 21, 1881	30
414	Feb. 8, 1881	3546	do	do	do	Apr. 12, 1881	20
415	Oct. 28, 1879	180	J. H. Baker	do	do	Nov. 4, 1879	50
416	......	......	John A. Baker	do	do	May 4, 1881	20
417	Aug. 21, 1880	2211	John S. Coffman	Galena	Floyd	Dec. 9, 1880	20
418	Aug. 6, 1881	7031	John B. James	New Albany	do	Nov. 7, 1879	16
419	Mar. 22, 1880	1570	William S. Kaler	Andersonville	Franklin	Jan. 3, 1881	......
420	Aug. 17, 1878	409	R. G. Little	Cartersburg	Hendricks	Nov. 10, 1879	16
421	Sept. 18, 1881	6015	Addison Hadley	Clayton	do	—— —, 1881	......
422	Sept. 18, 1879	963	Seth G. Bigelow	Silver Lake	Kosciusko	Nov. 23, 1880	16
423	......	......	do	do	do	Apr. 21, 1881	20
424	May 10, 1880	1923	John C. Lee	Butlerville	Jennings	Nov. 16, 1880	......
425	Mar. 20, 1880	1593	John Miller	Bluff Creek	Johnson	Nov. 16, 1880	......
426	Oct. 5, 1880	2390	John J. Demott	Franklin	do	Dec. 18, 1880	......
427	Oct. 5, 1880	2391	Abram A. Voorhies	do	do	Nov. 16, 1880	......
428	Sept. 11, 1880	2352	John Makemson	Pierceton	Kosciusko	Nov. 4, 1880	......
429	Apr. 1, 1880	1670	M. R. Barber	Silver Lake	do	Nov. 4, 1880	......
430	Apr. 2, 1880	1653	Robert McCloskey	Lagrange	Lagrange	Nov. 23, 1880	16
431	Apr. 20, 1880	1762	John L. Du Breuil	Crown Point	Lake	Dec. 31, 1880	16
432	Dec. 27, 1880	3366	Thomas J. Wood	do	do	Dec. —, 1880	20
433	Mar. 31, 1880	1520	Jacob Forsyth	Sheffield	do	Dec. —, 1880	20
434	Apr. 2, 1880	1696	Protective Fish'g Club	La Porte	La Porte	Nov. 4, 1880	......
435	Dec. 3, 1879	998	Samuel F. Williams	do	do	Nov. 4, 1880	......
436	June 30, 1880	2111	John Hickey	Anderson	Madison	Nov. —, 1880	16
437	Dec. 4, 1880	2896	F. M. Churchman	Indianapolis	Marion	Dec. 4, 1880	50
438	......	......	Staunton Churchman	do	do	Dec. 2, 1880	25
439	June 11, 1880	2067	E. J. Howland	do	do	Nov. 16, 1880	......
440	Feb. 18, 1878	187	R. W. Thompson	do	do	Nov. 16, 1880	......
441	Mar. 9, 1880	1484	James O. Parks	Bourbon	Marshall	Nov. 28, 1880	16
442	Feb. 28, 1880	1402	F. E. Worley	Ellettsville	Monroe	Nov. 16, 1880	......
443	Jan. 10, 1880	1110	M. P. Nelson	Ligonier	Noble	Nov. 4, 1880	......
444	Dec. 1, 1878	520	Calvin Fletcher	Spencer	Owen	Nov. 5, 1879	16
445	Jan. 27, 1880	1191	A. L. Lockridge	Greencastle	Putnam	Nov. 4, 1880	......
446	June 1, 1878	312	O. D. Ruple	South Bend	Saint Joseph	Nov. 14, 1879	16
447	Feb. 13, 1880	1324	R. A. Merithew	Rockport	Spencer	Nov. 16, 1880	......
448	May 3, 1880	1896	John Fisher	Liberty Mills	Wabash	Nov. 19, 1880	16
449	Mar. 1, 1880	1485	Edmund Holderman	do	do	Nov. —, 1880	16
450	Mar. 2, 1880	1465	Mark E. Reeves	Richmond	Wayne	Dec. 16, 1880	16
451	Apr. 16, 1880	1735	George H. Smith	Smithfield	do	Nov 24, 1880	16
452	Mar. 18, 1880	1572	P. M. Kent	Brookston	White	Nov. 4, 1880	......
453	Mar. 4, 1880	1495	John Matthews	Collamer	Whitley	Nov. 4, 1880	......

IOWA.

454	Oct. 28, 1880	2422	Lore Alford	Waterloo	Black Hawk	Nov. 9, 1880	......
455	Apr. 29, 1880	1863	T. B. Blake	Scranton Sta'n	Greene	Nov. 9, 1880	......
456	Oct. 25, 1880	2419	Benj. A. Spencer	Maquoketa	Jackson	Nov. 9, 1880	......
457	Mar. 9, 1880	186	B. F. Shaw	Anamosa	Jones	June 7, 1880	200
458	Feb. 25, 1880	1349	John Johnston	Lisbon	Linn	June 12, 1880	10
459	Jan. 19, 1880	1084	William G. Allen	Columbus City	Louisa	June 21, 1880	9
460	June 23, 1880	2100	S. E. Whicher	Muscatine	Muscatine	Nov. 8, 1880	......
461	Mar. 9, 1880	632	W. A Mynster	Council Bluffs	Pottawattamie	July 27, 1880	10
462	June 24, 1880	2097	John Scott	Nevada	Story	Feb. —, 1881	30

KANSAS.

463	May 15, 1880	1949	R. W. Case	Humboldt	Allen	Nov. —, 1879	10
464	Aug. 9, 1880	2202	Robert T. Wall	Fort Scott	Bourbon	Nov. 8, 1880	......
465	June 15, 1878	346	Timothy Jordan	Monmouth	Crawford	—— —, 1881	......
466	June 2, 1877	70	A. D. Blanchette	Aroma	Dickinson	June 2, 1880	......
467	Feb. 14, ——	1414	E. Z. Butcher	Solomon City	do	Jan. 12, 1880	7
468	......	......	do	do	do	June 15, 1880	8
469	Feb. 18, 1880	1389	O. F. Searl	do	do	Jan. 12, 1881	11
470	......	......	do	do	do	June 15, 1880	8
471	Jan. 15, 1880	1150	P. J. Peterson	Lawrence	Douglas	June 2, 1880	......

Table showing by States the final destination of carp distributed, &c.—Continued.

KANSAS—Continued.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
472	Nov. 13, 1880	2469	John D. Griffith	Ellsworth	Ellsworth	June 15, 1880	10
473			J. C. Howard	do	do	June 15, 1880	6
474	May 30, 1879	790	D. B. Long	do	do	Jan. 12, 1880	160
475			do	do	do	June 15, 1880	8
476	May 30, 1879	790	do	do	do	June 18, 1880	100
477	May 30, 1879	790	do	do	do	July 8, 1880	180
478	July 13, 1880	2166	Henry Rhoades	Gardner	Johnson	Nov. 8, 1880	
479	June 1, 1880	2029	Roswell G. Brooks	Council Grove	Morris	Nov. 8, 1880	
480	Apr. 6, 1880	1607	Oliver S. Munsell	do	do	June 2, 1880	10
481	June 1, 1880	2039	O. H. Smith	do	do	Nov. 8, 1880	
482	Oct. 4, 1880	2386	John Pickering	Fontana	Miami	Nov. 27, 1880	20
483			A. Obernhoff, jr	Centralia	Nemaha	Jan. 12, 1881	31
484	Mar. 12, 1880	1582	R. Robertson	Sabetha	do	June 2, 1880	
485	Mar. 12, 1881	3827	Thomas B. Sears	Churchill	Ottawa	June 15, 1880	8
486	Apr. 17, 1880	1808	D. H. Welch	Macksville	Stafford	June 21, 1880	
487	Oct. 20, 1880	2441	J. B. Mumaw	Vienna	Pottawatomie	Nov. 14, 1840	
488	Dec. 6, 1878	573	E. A. Thompson	Hutchinson	Reno	June 2, 1880	
489	Mar. —, 1881	4203	Benjamin Ladd	Mulvane	Sumner	Apr. 25, 1881	20

KENTUCKY.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
490	Apr. 17, 1879	715	J. M. Bell	Lawrenceburg	Anderson	—— —, 1879	16
491	May 3, 1880	1836	E. H. Mentz	Glascow Junc.	Barren	Nov. 16, 1880	
492	May 18, 1880	1962	W. L. Porter	Glasgow	do	Nov. 16, 1880	20
493	June 28, 1881	4866	Thomas G. Page	Rocky Hill	do	—— —, 1881	
494			J. R. Bascom		Bath	Nov. 18, 1880	20
495			Judge Withers		do	Nov. 18, 1880	25
496			E. E. Peck	Sharpsburg	do	Nov. 18, 1880	20
497	Nov. 1, 1881	8252	M. T. Graves	Bullitsville	Boone	—— —, 1881	
498	Nov. 19, 1880	2832	W. P. Andery	Paris	Bourbon	Nov. 19, 1880	27
499	Nov. 19, 1880	2834	H. C. Buckner	do	do	Nov. 19, 1880	27
500	Nov. 19, 1880	2835	Cath. Clay	do	do	Nov. 19, 1880	27
501	Nov. 19, 1880	2836	C. F. Clay	do	do	Nov. 19, 1880	30
502	Nov. 19, 1880	2833	E. F. Clay	do	do	Nov. 19, 1880	36
503	Nov. 19, 1880	2831	J. W. Ferguson	do	do	Nov. 19, 1880	27
504	Nov. 19, 1880	2821	Oscar A. Gilman	do	do	Nov. 19, 1880	20
505	Nov. —, 1880	5255	Charles P. Cecil		Boyle	Nov. 18, 1880	10
506	Nov. —, 1880	5258	James E. Cowen		do	Nov. 18, 1880	10
507	Nov. —, 1880	5254	F. S. Fisher		do	Nov. 18, 1880	125
508	Dec. —, 1880	5332	Edward McCarty		do	Dec. 24, 1880	20
509	Nov. 1, 1880	5261	F. Reid		do	Nov. 18, 1880	15
510	Nov. —, 1880	5253	J. A. Slaughter		do	Dec. 17, 1880	20
511	Oct. 22, 1882	15915	J. Bingham	Danville	do	Apr. 19, 1881	20
512	Jan. —, 1881	9839	R. H. Caldwell	do	do	Nov. 18, 1880	20
513	Aug. 23, 1881	5653	R. Q. Davis	do	do	—— —, 1881	
514	Jan. 29, 1879	619	F. A. Fisher	do	do	Oct. 31, 1879	12
515		5654	F. W. Handman	do	do	Dec. 14, 1880	20
516	—— —, 1881	5257	William Warren	do	do	Nov. 18, 1880	25
517			G. M. Welch, jr	do	do	Nov. 18, 1880	25
518	Dec. —, 1880	5362	J. G. Stephens		Breckinridge	Apr. 13, 1881	20
519	Jan. —, 1881	5333	W. D. Holt	Holt	do	Dec. 25, 1880	20
520			James A. Carr		Caldwell	Apr. 19, 1881	12
521			W. D. Kulpatrick		do	Apr. 19, 1881	15
522	Jan. —, 1881	9835	C. F. Allen	Princeton	do	Apr. 13, 1881	13
523	June 21, 1880	2089	Patrick H. Darby	do	do	Feb. 4, 1881	45
524			Patrick H. Darby	do	do	Apr. 9, 1881	45
525	Dec. —, 1880	5334	William F. Radford		Christian	Dec. 30, 1880	15
526	Dec. —, 1880	5323	C. J. Renfro		Clark	Dec. 24, 1880	20
527			L. M. Vanmeter		do	Dec. 22, 1880	20
528	Jan. —, 1881	5325	S. D. Goff	Winchester	do	Dec. 24, 1880	20
529	Feb. 9, 1880	1325	W. Miller	do	do	Oct. 26, 1880	560
530	Jan. —, 1881	5353	R. W. Wood	Albany	Clinton	Feb. 22, 1881	25
531	Nov. —, 1880	5289	Cyrus Cassell		Fayette	Nov. 18, 1880	10
532	Dec. —, 1880	5347	James E. Downing		do	Feb. 5, 1881	20
533	June 9, 1880	2059	Jacob H. Graves	Chilesburg	do	Nov. 16, 1880	
534	Oct. 27, 1879	947	Hon. James B. Beck	Lexington	do	—— —, 1879	500
535	Oct. 21, 1879	941	Hon. T. J. Bush	do	do	Oct. 31, 1879	16
536	Oct. 21, 1879	942	Judge J. H. Mulligan	do	do	Oct. 31, 1879	16
537	Nov. 18, 1880	2813	Benjamin Pettit	do	do	Nov. —, 1880	420
538	Oct. 31, 1879	2480	P. Henry Thomson	do	do	Oct. 31, 1879	16
539	Oct. 21, 1879	940	William Warfield	do	do	Oct. 31, 1879	16
540	Dec. —, 1880	5320	John Hay		Fleming	Dec. 22, 1880	20
541	Nov. —, 1880	5290	William Dudley		Franklin	Nov. 18, 1880	10
542	Dec. —, 1880	5307	A. W. Overton	Frankfort	do	Dec. 16, 1880	20
543	Jan. 19, 1878	182	E. E. Seobald	do	do	Nov. 16, 1879	

Table showing by States the final destination of carp distributed, &c.—Continued.

KENTUCKY—Continued.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
544	Apr. —, 1880	5373	A. D. McNeily		Fulton	Dec. 20, 1880	20
545	Nov. 18, 1880	2817	William Pointer	Sherman	Grant	Nov. 18, 1880	100
546	Nov. —, 1880	5291	R. Y. Bush		Hancock	Dec. 10, 1880	25
547			Jefferson Steuett		do	Dec. 10, 1880	25
548	Apr. —, 1880	5372	E. R. Mercer		Hardin	Dec. 15, 1880	20
549	Dec. —, 1880	5301	R. M. Parks		do	Dec. 15, 1880	20
550	Jan. —, 1881	5367	John Richards	Nolin	do	Apr. 14, 1881	20
551			T. J. Megibben	Cynthiana	Harrison	Dec. 30, 1880	35
552	Dec. —, 1880	5354	W. K. Jameson		Hart	Apr. 8, 1881	25
553	Jan. —, 1881	11692	H. W. Moneypenny	Munfordsville	do	—— —, 1880	
554			C. J. Walton	do	do	Apr. 8, 1881	75
555	Dec. —, 1880	5321	W. R. Bradley		Henry	Dec. 22, 1880	20
556	Dec. —, 1880	5314	John W. Matthews		do	Dec. 22, 1880	20
557	Nov. 18, 1880	2820	William Thorne	Eminence	do	Nov. 18, 1880	100
558	Dec. —, 1880	5306	Thomas Coleman		do	Dec. 16, 1880	20
559	Jan. 11, 1882	8179	William McElwain	Sulphur	do	Dec. 16, 1880	20
560	Dec. —, 1880	5319	N. P. Moss		Hickman	Dec. 22, 1880	20
561	Dec. —, 1880	5350	M. W. Bishop		Hopkins	Feb. 1, 1881	25
562	Dec. —, 1880	5351	J. H. Lunsford		do	Feb. 5, 1881	25
563	Dec. —, 1880	5352	J. W. Pritchett		do	Feb. 5, 1881	25
564	Mar. 4, 1880	1491	J. B. Walker	Madisonville	do	Nov. 16, 1880	
565			do	do	do	Feb. 5, 1881	50
566	Dec. —, 1880	5348	John L. Woolfolk	do	do	Feb. 5, 1881	25
567	Dec. —, 1880	5368	P. Caldwell		Jefferson	Mar. 4, 1881	12
568	Dec. —, 1880	5328	George W. Crum		do	Dec. 24, 1880	20
569	Dec. —, 1880	5310	H. A. Dumesneil		do	Dec. 20, 1880	15
570	Dec. —, 1880	5370	Thomas S. Kennedy		do	May 4, 1881	12
571			William Griffith	Louisville	do	—— —, 1879	
572	Dec. —, 1880	5369	George K. Speed	do	do	May 4, 1881	20
573	Dec. —, 1880	5327	Joseph Sweitzen		do	Dec. 24, 1880	20
574			J. B. Wilder		do	May 4, 1881	16
575	Mar. 13, 1880	1519	L. Washburn	Lyndon	do	Apr. 9, 1881	20
576	Mar. 31, 1880	1519	do	do	do	Nov. 16, 1880	
577	Feb. 10, 1880	1284	James C. Blick	Covington	Kenton	Nov. —, 1880	
578	Jan. 30, 1879	1186	W. S. Porter	do	do	Nov. 16, 1880	
579	Feb. 9, 1880	1382	Amos Shinkle	do	do	Nov. 16, 1880	
580			F. A. Schinkle	do	do	Dec. 17, 1880	20
581	Nov. 18, 1880	2805	J. M. Chambers	Independence	do	Nov. 18, 1880	130
582	June 4, 1878	319	G. M. Carlisle	Key West	do	Oct. 31, 1879	17
583	June 18, 1880	2086	Jacob Metz	Kenton	do	Nov. 16, 1880	
584	Nov. —, 1880	5262	W. H. Graddy		Lincoln	Nov. 18, 1880	10
585	Nov. —, 1880	5256	J. W. Weatherford		do	Nov. 18, 1880	25
586	Dec. —, 1880	5366	George W. Browder		Logan	Apr. 13, 1881	20
587	Dec. —, 1880	5360	John I. Ferguson		do	Apr. 13, 1881	20
588	Dec. —, 1880	5329	S. H. Gordon		do	Dec. 24, 1880	20
589	Dec. —, 1880	5293	N. Long		do	Dec. 10, 1880	15
590	Dec. —, 1880	5317	L. & R. A. Paisley	Adairville	do	Dec. 22, 1880	20
591	Feb. 1, 1880	1282	T. H. Baird	do	do	Dec. 20, 1880	20
592	Apr. 30, 1880	1837½	L. Paisley	do	do	Nov. 16, 1880	
593	Apr. 30, 1880	1837	R. A. Paisley	do	do	Nov. 16, 1880	
594	Apr. 29, 1880	1776	George R. Browder	Olmstead	do	Nov. 16, 1880	
595	Jan. 21, 1881	3428	William M. Browder	do	do	Apr. 13, 1881	20
596	Jan. 21, 1881	3429	W. R. Browder	do	do	Apr. 13, 1881	20
597	Jan. —, 1881	11711	George Hutchings	do	do	Dec. 22, 1880	20
598	Apr. 17, 1880	1709	John B. Hutchings	do	do	Nov. 16, 1880	
599			J. B. Briggs	Russellville	do	Dec. 10, 1880	15
600			Charles Anderson		Lyon	Apr. 19, 1881	15
601	Dec. —, 1880	5357	W. J. Stone		do	Apr. 9, 1881	40
602	Dec. —, 1880	5300	William Arnold		Madison	Dec. 14, 1880	15
603	Dec. —, 1880	5298	L. E. Francis		do	Dec. 14, 1880	12
604	Dec. —, 1880	5299	J. B. McCreary		do	Dec. 14, 1880	12
605	Dec. —, 1880	5361	J. Speed Smith		do	Apr. 13, 1881	20
606	Dec. —, 1880	5297	C. M. Clay		do	Dec. 14, 1880	20
607	Jan. —, 1881	9832	William Gibson	Richmond	do	Jan. 1, 1881	13
608	Dec. —, 1880	5355	H. Johnson & Sons		Marion	Apr. 9, 1881	20
609	Dec. —, 1880	5295	John T. Levi		Meade	Dec. 14, 1880	20
610	Dec. —, 1880	5363	B. Magoffin		Mercer	Apr. 13, 1881	30
611	Dec. —, 1880	5308	C. E. Williams, jr		do	Dec. 16, 1880	20
612	Apr. 19, 1880	1741	W. H. Clack	Knob Lick	Metcalfe	Nov. 16, 1880	
613	June 1, 1880	2028	Asa Bean	Mt. Sterling	Montgomery	Nov. 16, 1880	60
614	—— —, 1881	12621	Wes. Chenault	do	do	Nov. 18, 1880	35
615	Aug. 1, 1881	13791	George Cockerell	do	do	Nov. 18, 1880	20
616			J. W. Gatewood	do	do	Nov. 18, 1880	52
617	Jan. —, 1881	9868	Clarence Judy	do	do	Nov. 18, 1880	19
618			John T. Magowan	do	do	Nov. 18, 1880	16
619	Feb. 13, 1880	1381	Sterling Fishing Club	do	do	Nov. 16, 1880	
620	Jan. —, 1881	9911	Silas Stofer	do	do	Nov. 18, 1880	21

Table showing by States the final destination of carp distributed, &c.—Continued.

KENTUCKY—Continued.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
621	Nov. 18, 1880	2816	Dr. Van Antwerp	Mt. Sterling	Montgomery	Nov. 18, 1880	360
622	—— —, 1881	11528	E. W. Hall	Greenville	Muhlenburgh	Jan. 1, 1881	18
623	Dec. —, 1880	5322	R. Huddleson		Nelson	Dec. 24, 1880	20
624	Dec. —, 1880	5302	William Johnston		do	Dec. 16, 1880	20
625	Jan. —, 1881	5324	Lud McKay	Bardstown	do	Dec. 24, 1880	20
626	Jan. —, 1881	5359	R. C. Prather, sr	Woodl'd Mills*		Apr. 13, 1881	20
627	Dec. —, 1880	5304	A. W. Hardin		Oldham	Dec. 16, 1880	12
628	Jan. 12, 1880	1036	Dr. A. W. Kaye	Pewee Valley	do	Nov. 6, 1880	
629	Dec. 29, 1879	1036	do	do	do	Apr. 9, 1878	20
630			William A. Gordon	New Orleans†		Jan. —, 1881	80
631	Oct. 24, 1879	946	Thomas Payne	Georgetown	Scott	Oct. 31, 1879	16
632	Nov. 18, 1880	2818	Henry Wolfe	do	do	Nov. 18, 1880	200
633	Dec. —, 1880	5326	C. W. Haddox		Shelby	Dec. 24, 1880	20
634	Dec. —, 1880	5315	J. M. McGrath		do	Dec. 22, 1880	20
635	Dec. —, 1880	5311	James B. Scearce		do	Dec. 20, 1880	20
636	Dec. —, 1880	5331	Seldon B. Lard		do	Dec. 24, 1880	20
637	Dec. —, 1880	5330	Benjamin F. Bryant	Shelbyville	do	Dec. 24, 1880	20
638	Dec. —, 1880	5330	do		do	Nov. 15, 1881	20
639	Dec. —, 1880	5305	S. H. Dickinson		Todd	Dec. 16, 1880	20
640	Dec. —, 1880	5336	W. L. Kimbrough		do	Dec. 30, 1880	20
641	Dec. —, 1880	5335	Lyman McComb		do	Dec. 30, 1880	15
642	Jan. —, 1881	5364	C. M. Russell	Elkton	do	Apr. 13, 1881	20
643	Apr. 13, 1880	1689	S. H. Dickinson	Trenton	do	Dec. 16, 1880	
644	Jan. —, 1881	5316	Crittenden Reeves	do	do	Dec. 22, 1880	20
645	Jan. 31, 1881	1259	J. G. Taylor	Boxville	Union	Nov. 16, 1880	
646	Dec. —, 1880	5345	B. M. Kirby		Warren	Jan. 1, 1881	16
647	Dec. —, 1880	5343	Joseph Smith		do	Jan. 1, 1881	16
648	Dec. —, 1880	5340	T. P. Smith		do	Jan. 1, 1881	16
649	Apr. 14, 1880	1708	Henry T. Clark	Bowling Green	do	Nov. 16, 1880	
650	Apr. 26, 1880	1815	Samuel Cook	do	do	Nov. 16, 1880	
651	Dec. —, 1880	5344	S. W. Combs	do	do	Jan. 1, 1881	16
652	Dec. —, 1880	5337	E. L. Hines	do	do	Jan. 1, 1881	20
653	Dec. —, 1880	5342	Alexander Loving	do	do	Jan. 1, 1881	16
654	Apr. 18, 1880	1816	John Vogle	do	do	Nov. 16, 1880	16
655	Apr. 18, 1880	1816	do	do	do	Jan. 1, 1881	16
656	Apr. 26, 1880	1816	do	do	do	Nov. 16, 1880	
657			Lemuel Stallard		do	June 1, 1881	16
658	Nov. —, 1880	5266	A. J. Alexander		Woodford	Nov. 18, 1880	10
659	Nov. —, 1880	5283	C. J. Arnold		do	Nov. 18, 1880	10
660	Nov. —, 1880	5273	A. L. Childres		do	Nov. 18, 1880	10
661	Nov. —, 1880	5277	Charles Cox		do	Nov. 18, 1880	10
662	Nov. —, 1880	5280	D. W. Edwards		do	Nov. 18, 1880	10
663	Nov. —, 1880	5272	G. M. Emack	Versailles	do	Nov. 18, 1880	10
664	Nov. —, 1880	5288	F. B. Harper		do	Nov. 18, 1880	10
665	Nov. —, 1880	5279	William Henry		do	Nov. 18, 1880	10
666	Nov. —, 1880	5282	Thomas M. Hiffner	Mortonsville	do	Nov. 18, 1880	10
667	Nov. —, 1880	5269	A. C. Hunter		do	Nov. 18, 1880	10
668	Nov. —, 1880	5274	J. H. Jesse		do	Nov. 18, 1880	10
669	Nov. —, 1880	5281	John G. Master		do	Nov. 18, 1880	10
670	Nov. —, 1880	5263	M. S. O'Neal	Versailles	do	Nov. 18, 1880	10
671	Nov. —, 1880	5276	P. G. Powell	do	do	Nov. 18, 1880	10
672	Nov. —, 1880	5287	Mrs. Mary Shipp		do	Nov. 18, 1880	10
673	Nov. —, 1880	5275	Charles Stevenson		do	Nov. 18, 1880	10
674	Nov. —, 1880	5286	Thomas H. Swoop		do	Nov. 18, 1880	10
675	Nov. —, 1880	5265	W. J. Turner		do	Nov. 18, 1880	10
676			J. W. Twyman		do	Nov. 18, 1880	10
677	Nov. —, 1880	5284	H. C. White		do	Nov. 18, 1880	10
678	Nov. —, 1880	5267	James Wilhoit		do	Nov. 18, 1880	10
679	Nov. —, 1880	5271	D. J. Williams		do	Nov. 18, 1880	10
680			J. S. Withrow		do	Nov. 18, 1880	10
681			S. L. Wooldridge		do	Nov. 18, 1880	10
682	Nov. —, 1880	5278	W. H. Wooldridge		do	Nov. 18, 1880	10
683	Jan. —, 1881	5264	G. T. Graddy	Spring	do	Nov. 18, 1880	10
684	Jan. —, 1881	5268	M. B. Gratz	do	do	Nov. 18, 1880	10

LOUISIANA.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
685	Feb. 2, 1881	3534	James L. Stewart	Arcadia	Bienville	Feb. 2, 1881	
686	Apr. 9, 1880	1810	Joseph M. White	Haynesville	Claiborne	Jan. 8, 1881	
687	June 12, 1879	935	Marcus T. Carpenter	Port Hudson	East Baton Rouge.	Jan. 6, 1881	20
688	Aug. 25, 1880	2368	R. J. Hummel	do	do	Jan. 1, 1881	20
689	May 17, 1879	763	Gustave Schmidt	Thibodeaux	La Fourche	Jan. —, 1881	
690	Dec. 11, 1880	3071	Richard H. Yale	New Orleans	Orleans	Jan. 3, 1881	20
691	July 29, 1880	2190	Eugene A. Duchamp	St. Martinville	Saint Martin's	—— —, 1880	
692	July 10, 1880	2161	St. Valery Martin	do	do	Jan. 29, 1881	20

* Obion County, Tenn.

† Orleans County, La.

Table showing by States the final destination of carp distributed, &c.—Continued.

MAINE.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
693	May —, 1881	4646	S. H. Chandler	New Gloucest'r	Cumberland	—— —, 1881	20
694	Dec. 29, 1879	1035	George H. M. Barrett.	Rockport	Knox	Nov. 23, 1880	15
695	Oct. 4, 1880	2385	Alexander Johnston	Wiscasset	Lincoln	Nov. 5, 1880	20
696	Mar. 30, 1880	1622	J. D. Wilder	Hiram	Oxford	Dec. 10, 1880	15
697	May 19, 1880	1974	Joseph Young	South Sanford	York	Nov. 4, 1880	15

MARYLAND.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
698	Nov. 10, 1880	2732	Thomas G. McCulloh.	Frostburgh	Alleghany	Nov. 10, 1880	40
699			James Boyle		Anne Arundel	June 8, 1880	10
700	Nov. 21, 1879	2535	Samuel Anderson	Davidsonville	do	Nov. 21, 1879	20
701	Nov. 13, 1879	2496	James A. Inglehart	do	do	Nov. 13, 1879	40
702			Thomas S. Inglehart.	do	do	Nov. 13, 1879	20
703	May 4, 1880	1850	A. J. Gall	Jessup's	do	May 8, 1880	20
704			Mrs. P. R. Uhler	Millersville	do	Nov. 18, 1880	50
705	Nov. 11, 1880	2752	J. T. Popplein	Patuxent	do	Nov. 11, 1880	50
706			F. K. Jenkins	Rhode River.	do	May 12, 1880	20
707	Nov. 11, 1879	2491	Joseph V. Follansbee.	Sappington	do	Nov. 11, 1879	20
708	Nov. 11, 1879	2491	do	do	do	Dec. 9, 1880	50
709	Mar. 19, 1881	8529	Thomas Baldwin	Baldwin	Baltimore	Mar. 19, 1881	50
710			George Appold	Baltimore	do	May 8, 1880	20
711	Nov. 16, 1880	2795	Silas Baldwin	do	do	Nov. 16, 1881	50
712			M. C. Barclay	do	do	Feb. 11, 1880	20
713	Nov. 11, 1880	2751	Philip Bavann	do	do	Nov. 11, 1880	50
714			O. R. Benson		do	Dec. 4, 1880	50
715	Nov. 22, 1880	2866	Dr. C. E. Coates	Baltimore	do	Nov. 22, 1880	50
716	Nov. 9, 1880	2727	Thomas R. Coward	do	do	Nov. 9, 1880	50
717	Dec. 10, 1880	3242	Rev. F. Dalrymple	do	do	Dec. 10, 1880	50
718	Nov. 12, 1879	2494	J. A. Edmondson	do	do	Nov. 12, 1879	20
719	Jan. 24, 1881	2734	George H. Forster	do	do	Nov. 10, 1880	50
720			do	do	do	Jan. 24, 1881	50
721	Oct. 22, 1879	933	John W. Garrett	do	do	Oct. 28, 1879	50
722			M. Gill	do	do	May 8, 1880	20
723	Mar. 10, 1880	1460	W. A. Hammond	do	do	Nov. 2, 1880	50
724	Mar. —, 1881	4213	James R. Herbert	do	do	Apr. 9, 1881	50
725	Nov. 18, 1880	2808	C. Hoffman	do	do	Nov. 18, 1880	50
726	Dec. 9, 1880	3241	Isaac D. Jones	do	do	Dec. 9, 1880	40
727	Nov. 24, 1880	3016	J. F. Krunelberg	do	do	Nov. 24, 1880	50
728	Apr. 26, 1881	8558	J. Boyten Lee	do	do	Apr. 26, 1880	25
729	Dec. 18, 1879	2624	Mathias A. Leimskuhler.	do	do	Dec. 18, 1879	20
730	Dec. 18, 1879	2624	do	do	do	Nov. 18, 1880	......
731	Jan. 8, 1880	2641	Thomas W. Levering.	do	do	Jan. 8, 1880	20
732			do	do	do	May 21, 1880	10
733	Nov. 18, 1879	2505	Otto Lugger	do	do	Nov. 18, 1879	20
734	Nov. 1, 1880	2702	Felix McCurley	do	do	Nov. 2, 1880	50
735	Jan. 28, 1880	2665	do	do	do	Jan. 28, 1880	20
736	Dec. 18, 1880	3250	Ferdinand Meyer	do	do	Dec. 18, 1880	150
737	Dec. 12, 1879	2614	J. R. Mordecai	do	do	Dec. 12, 1879	20
738	Dec. 12, 1879	2614	do	do	do	Nov. 12, 1880	50
739	Nov. 12, 1880	2768	G. Y. Page	do	do	Nov. 12, 1880	50
740			R. W. Rasin	do	do	June 7, 1880	10
741	Apr. 1, 1881	8675	G. W. Ridgely	do	do	Apr. 1, 1881	50
742	Nov. 22, 1880	2867	P. Schlesinger	do	do	Nov. 22, 1880	50
743			H. C. Seymour	do	do	May 18, 1880	10
744	Nov. 10, 1880	2736	do	do	do	Nov. 10, 1880	50
745	Nov. 5, 1880	2714	William Shirley	do	do	Nov. 5, 1880	50
746	Nov. 11, 1881	8539	do	do	do	Nov. 29, 1880	50
747	Nov. 10, 1880	2737	George Small	do	do	Nov. 10, 1880	24
748	Jan. 22, 1882	8527	do	do	do	Jan. 22, 1881	50
749			do	do	do	Apr. 13, 1881	25
750			G. W. Small	do	do	May 13, 1880	10
751	Mar. 3, 1881	8530	John T. Street	do	do	Feb. 10, 1880	20
752			do	do	do	Mar. 3, 1881	50
753	Mar. 10, 1881	3775	H. C. Tieck	do	do	Nov. 9, 1880	50
754	Feb. 11, 1881	8531	James E. Tyson	do	do	Feb. 11, 1881	50
755	Nov. 10, 1880	2738	A. J. Ulman	do	do	Nov. 10, 1880	50
756	May 13, 1881	4600	Michael Willax	do	do	May —, 1881	25
757	Nov. 15, 1880	2773	Alexander Wolle, jr	do	do	Nov. 15, 1880	50
758			Richard H. Woollen	Brooklandville	do	May 12, 1880	20
759	May. 1, 1881	8557	John Moran	do	do	May 1, 1881	50
760	Nov. 27, 1879	2568	S. M. Shoemaker	Green Spring Furnace.	do	Nov. 27, 1879	30
761	Nov. 27, 1879	2568	do	do	do	Nov. 28, 1879	50
762			L. Keidel	Catonsville	do	May 6, 1880	20
763	Oct. 29, 1881	2611	J. R. Long	do	do	Dec. 11, 1879	20

Table showing by States the final destination of carp distributed, &c.—Continued.

MARYLAND—Continued.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
764	Dec. 11, 1879	2611	J. R. Long	Catonsville	Baltimore	Nov. 20, 1880	40
765	Apr. 18, 1881	8532	E. A. Welch	do	do	Apr. 18, 1881	50
766	Nov. 11, 1879	2492	A. T. Love	Cockeysville	do	Nov. 11, 1879	20
767	Nov. 2, 1881	2561	Charles J. Riddle	Fork	do	Nov. 26, 1881	20
768	Nov. 16, 1880	2792	W. H. Riddle	do	do	Nov. 16, 1880	50
769	Nov. 8, 1879	2490	Henry Lange	Gardenville	do	Nov. 8, 1879	20
770	Jan. 7, 1880	2640	Joseph W. Mowell	Glencoe	do	Jan. 7, 1880	20
771	Jan. 7, 1880	2640	do	do	do	Oct. 28, 1880	50
772	Jan. 7, 1880	2640	do	do	do	Jan. 13, 1881	55
773	Nov. 15, 1879	2500	John Wilson Brown	Govanstown	do	Nov. 15, 1879	20
774			Samuel W. Regester	do	do	May 7, 1880	20
775	Jan. 3, 1882	12938	James Burton	Greenwood	do	Jan. 19, 1881	100
776	Apr. 5, 1881	8528	do	do	do	Apr. 5, 1881	50
777			Washington Shearman	do	do	May 15, 1880	10
778	Nov. 27, 1880	3019	do	do	do	Nov. 27, 1880	50
779	Nov. 29, 1880	3020	D. A. Dickenson	Harrisonville	do	Nov. 29, 1880	50
780	Dec. 18, 1880	3247	John S. Miller	do	do	Dec. 18, 1880	75
781	Nov. 22, 1879	2543	F. G. Mitchell	Hereford	do	Nov. 22, 1879	20
782	Nov. 22, 1879	2543	do	do	do	Dec. 11, 1880	50
783	Dec. 12, 1879	2615	A. E. Groff	Hiland Park*	do	Dec. 12, 1879	20
784			Edwin F. Jenkins	Long Green	do	May 6, 1880	20
785	Nov. 24, 1879	2552	George M. Horn	Lutherville	do	Nov. 24, 1879	20
786	Nov. 15, 1880	2776	Andrew Reese	do	do	Nov. 15, 1880	50
787	Dec. 13, 1879	2617	William Allen	McDonogh	do	Dec. 13, 1879	20
788	Dec. 13, 1879	2617	do	do	do	Nov. 11, 1880	50
789			William J. Bland	Mt. Washingt'n	do	Mar. 22, 1881	50
790	June 12, 1880	2649	William M. Baker	North Branch	do	Jan. 12, 1880	20
791	Nov. 28, 1879	2573	W. H. Hoffman	Paper Mills	do	Nov. 28, 1879	20
792	Nov. 12, 1879	2493	William Sherley	Parkton	do	Nov. 12, 1879	20
793			S. V. Trump	Shane	do	Nov. 15, 1879	20
794	Nov. 9, 1880	2726	T. V. Richardson	Phœnix	do	Nov. 9, 1880	50
795	Nov. 27, 1879	2567	Thomas J. Myer	Pikesville	do	Nov. 27, 1879	20
796	Nov. 12, 1880	2765	William Norris	Reisterstown	do	Nov. 12, 1880	50
797	Nov. 15, 1879	2501	Isaac Hartman	Rider	do	Nov. 15, 1879	20
798	Nov. 15, 1880	2775	J. Sewell Glenn	Rossville	do	Nov. 15, 1880	50
799	Nov. 15, 1880	2775	do	do	do	Dec. 10, 1880	40
800			Charles Trump	do	do	May 10, 1880	20
801	Apr. 10, 1880	1734	do	do	do	Nov. 15, 1880	50
802	Apr. 10, 1880	1734	do	do	do	Dec. 13, 1880	100
803	Dec. 13, 1879	2618	Henry Cragg	Saint Denis	do	Dec. 13, 1879	20
804	Dec. 3, 1880	3032	William Bower	Sweet Air	do	Dec. 3, 1880	50
805	Dec. 3, 1880	3033	Dixon Brown	do	do	Dec. 3, 1880	50
806	Dec. 4, 1880	3035	E. Herman	Towson	do	Dec. 4, 1880	50
807	Dec. 4, 1880	3036	Charles B. McClean	do	do	Dec. 4, 1880	50
808	Dec. 5, 1879	2584	C. B. Slingluff	do	do	Dec. 5, 1879	20
809	Dec. 5, 1879	2584	do	do	do	Dec. 4, 1880	50
810	Nov. 1, 1880	2700	Henry R. Wilson	Waverly	do	Nov. 1, 1880	50
811	Nov. 18, 1880	2810	H. O. Hofman	Woodberry	do	Nov. 18, 1880	50
812	Nov. 18, 1880	2811	Mrs. P. R. Whitney	do	do	Nov. 18, 1880	50
813			Daniel J. Waldron	Huntingtown	Calvert	Nov. 22, 1879	86
814			J. W. Shemwell	Pr. Frederick-town.	do	Mar. 19, 1881	50
815			William Birkigt	Bethlehem	Caroline	May 11, 1880	10
816	Nov. 22, 1880	3008	do	do	do	Nov. 22, 1880	40
817	May 4, 1880	1849	James E. Hignutt	Denton	do	May 12, 1880	10
818			do	do	do	Nov. 19, 1880	40
819	Nov. 19, 1881	3015	J. W. Kerr	do	do	Nov. 22, 1880	40
820	Nov. 22, 1879	2545	Richard H. Comegys	Greensborough	do	Nov. 22, 1879	20
821	Nov. 22, 1879	2550	H. C. Comegys	do	do	Nov. 22, 1879	20
822	Nov. 22, 1879	2548	William H. Comegys	do	do	Nov. 22, 1879	20
823			T. Smith	Denton	do	Nov. 19, 1880	40
824	Dec. 16, 1879	2623	D. J. Zacharias	Greensborough	do	Dec. 16, 1879	20
825	Dec. —, 1880	5249	William Lisk	Preston	do	May 28, 1880	20
826	Nov. 22, 1879	2458	Daniel S. Sullivan	do	do	Nov. 22, 1879	86
827			George Hoffacker		Carroll	July 22, 1880	19
828			Dr. J. Weaver		do	May 27, 1880	10
829	Jan. 20, 1882	8569	David Englar	Avondale	do	Jan. 20, 1881	250
830			William Arbaugh	Carrollton	do	Feb. 5, 1881	100
831	Feb. 31, 1881	2544	H. T. Weaver	do	do	Nov. 22, 1879	20
832			do	do	do	Feb. 5, 1881	100
833	Nov. 18, 1880	2809	George W. Armacost	Finksburgh	do	Nov. 18, 1880	50
834	Nov. 15, 1880	2774	Jeremiah Rhinehart	Frizellburgh	do	Nov. 15, 1880	50
835	Nov. 15, 1880	2778	Simon P. Weaver	do	do	Nov. 15, 1880	50
836	Jan. 16, 1880	2663	John Wolf	do	do	Jan. 16, 1880	20
837			Fred. Zahn	do	do	Jan. 16, 1880	20
838	Nov. 15, 1880	2772	John N. Zahn	do	do	Nov. 15, 1880	50
839	Jan. 13, 1882	8566	John T. Knox	Gamber	do	Jan. 31, 1881	50
840	Apr. 19, 1881	8586	Cornelius Brashers	Mount Airy	do	Apr. 19, 1881	50
841	Apr. 19, 1881	8585	Francis Brashers	do	do	Apr. 19, 1881	50

*Baltimore P. O.

Table showing by States the final destination of carp distributed, &c.—Continued.

MARYLAND—Continued.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
842	Apr. 22, 1881	8584	R. J. Brashers	Mount Airy	Carroll	Apr. 22, 1881	50
843	Apr. 22, 1881	8594	W. B. Condon	do	do	Apr. 22, 1881	50
844			A. G. Davis	do	do	Dec. 17, 1880	75
845	Apr. 22, 1881	8593	W. C. Gilbert	do	do	Apr. 22, 1881	50
846	Apr. 22, 1881	8595	John S. Long	do	do	Apr. 22, 1881	50
847			J. B. Runkles	do	do	May 18, 1880	10
848	Dec. 17, 1879	2610	Mathias S. Bogan	Silver Run	do	Dec. 11, 1879	20
849	Dec. 10, 1879	2609	John W. Rittase	do	do	Dec. 11, 1879	20
850	Nov. 19, 1880	2822	Joseph Bankert	Stonersville	do	Nov. 19, 1880	50
851	Nov. 19, 1880	2826	J. F. Shade	do	do	Nov. 19, 1880	50
852	Nov. 19, 1880	2823	L. D. Wantz	do	do	Nov. 19, 1880	50
853			Lewis Barlow	Sykesville	do	May 18, 1880	10
854	May 8, 1880	1916	do	do	do	Oct. 22, 1880	20
855	May 8, 1880	1916	do	do	do	Nov. 12, 1880	50
856			Casper Erck	do	do	May 18, 1880	10
857	Nov. 8, 1880	2764	John T. Ridgely	do	do	Nov. 12, 1880	50
858	Nov. 24, 1880	3017	Abram E. Null	Union Bridge	do	Nov. 24, 1880	50
859	Nov. 27, 1881	8563	James W. Ogle	do	do	Nov. 27, 1880	40
860	Dec. 5, 1881	8575	D. Rinehart	do	do	Dec. 24, 1880	75
861	Jan. 20, 1882	8568	Solomon Shepherd	do	do	Jan. 20, 1881	250
862	Jan. 20, 1882	8567	Pemberton Wood	do	do	Jan. 15, 1881	250
863	Nov. 19, 1880	2830	William H. Hoffman	Uniontown	do	Nov. 19, 1880	40
864	Nov. 19, 1880	2825	Daniel Baumgarten	Westminster	do	Nov. 19, 1880	50
865			Granv. Coppersmith	do	do	Nov. 19, 1880	20
866	Nov. 11, 1880	2746	F. E. Cunningham	do	do	Nov. 11, 1880	50
867	Nov. 19, 1879	2511	W. A. Cunningham	do	do	Nov. 19, 1879	20
868	Nov. 30, 1880	3027	J. T. Diffenbaugh	do	do	Nov. 30, 1880	50
869	Dec. 30, 1879	2635	Theodore F. Englar	do	do	Dec. 30, 1879	20
870	Dec. 30, 1879	2635	do	do	do	Nov. 15, 1880	50
871	Nov. 30, 1880	3025	H. Haines	do	do	Nov. 30, 1880	50
872	Jan. 16, 1880	2662	Dr. Heoning	do	do	Jan. 16, 1880	20
873	Nov. 11, 1880	2745	William A. McKillip	do	do	Nov. 11, 1880	50
874	Nov. 22, 1879	2541	H. L. Motter	do	do	Nov. 22, 1879	20
875	Nov. 15, 1880	2777	David Reese	do	do	Nov. 15, 1880	50
876	Nov. 30, 1880	3023	John D. Roop	do	do	Nov. 30, 1880	50
877	Nov. 17, 1881	2636	Samuel Roop	do	do	Nov. 15, 1880	50
878	Dec. 30, 1879	2634	Charles Schaeffer	do	do	Dec. 30, 1879	20
879	Dec. 30, 1879	2634	do	do	do	Nov. 19, 1880	50
880	Nov. 30, 1880	3024	Jeremiah Schaeffer	do	do	Nov. 30, 1880	50
881	Nov. 17, 1880	2804	Milton Schaeffer	do	do	Nov. 17, 1880	1000
882	Nov. 30, 1880	3026	J. C. Shreve	do	do	Nov. 30, 1880	50
883	Nov. 10, 1880	2733	John E. Smith	do	do	Nov. 10, 1880	40
884	Nov. 19, 1880	2824	Jesse Sullivan	do	do	Nov. 19, 1880	50
885	May 4, 1880	1828	George S. Yingling	do	do	—— —, 1880	....
886	Nov. 24, 1881	2661	F. Zahn	do	do	Nov. 15, 1880	50
887	Nov. 11, 1880	2750	A. J. Michener	Colora	Cecil	Nov. 11, 1880	40
888			James C. Bell	Conowingo	do	Apr. 25, 1881	40
889			A. W. Mitchell	Elkton	do	Nov. 27, 1880	40
890	Oct. 5, 1880	2389	David Scott	do	do	Nov. 1, 1880	40
891			—— Adams	Port Deposit	do	Mar. 31, 1881	50
892	Mar. 31, 1881	8606	F. S. Everist	do	do	Mar. 31, 1881	50
893	Mar. 19, 1881	8604	J. M. Touchstone	do	do	Mar. 22, 1881	100
894			E. H. Reynolds	Rising Sun	do	Apr. 20, 1881	120
895	Dec. 1, 1880	3030	John M. Rawlings	Rowlandsville	do	Dec. 1, 1880	75
896	Dec. —, 1880	5241	Thomas L. Gardiner	Bryantown	Charles	Apr. 4, 1881	30
897	Dec. —, 1880	5242	H. L. Mudd	do	do	Apr. 4, 1881	30
898	Apr. 4, 1881	5240	Samuel A. Mudd	do	do	Apr. 4, 1881	40
899			W. H. Grane	Airey's	Dorchester	May 7, 1880	20
900	Nov. 22, 1879	2549	William R. Hayward	Cambridge	do	Nov. 22, 1879	20
901			George J. Meekins	do	do	Dec. 4, 1879	20
902	Nov. 22, 1879	2551	do	do	do	Nov. 22, 1879	40
903	Nov. 22, 1879	2551	do	do	do	Dec. 1, 1879	20
904	Dec. —, 1880	5248	S. L. Webster	East New Market.	do	May 28, 1881	40
905			William F. Boland		Frederick	May 12, 1880	10
906			Daniel Mainhart		do	May 12, 1880	20
907			Levi Pierce		do	June 4, 1880	10
908	Jan. 16, 1880	2664	Charles J. Lewis	Frederick	do	Jan. 16, 1880	50
909		5243	G. William Smith	do	do	Dec. —, 1880	40
910	Feb. 1, 1881	8623	William Todd	do	do	Feb. 14, 1881	50
911	Nov. 27, 1880	3018	John H. Williams	do	do	Nov. 27, 1880	40
912			C. M. Riggs	Ijamsville	do	May 19, 1880	10
913	Dec. 4, 1880	3034	do	do	do	Dec. 4, 1880	50
914	Oct. 11, 1880	2398	R. R. Buckey	Johnsville	do	Nov. 10, 1880	40
915	Nov. 16, 1880	2787	George W. Miller	Lewiston	do	Nov. 16, 1880	50
916	Nov. 16, 1880	2788	Lewis E. Miller	do	do	Nov. 16, 1880	50
917	Dec. 6, 1879	2587	John F. Eyler	Libertytown	do	Dec. 6, 1879	20
918	Dec. 29, 1879	2633	Charles D. Walker	New London	do	Dec. 29, 1879	20
919	Jan. 8, 1880	2645	John Burgess	New Market	do	Jan. 8, 1880	20

Table showing by States the final destination of carp distributed, &c.—Continued.

MARYLAND—Continued.

Serial number.	Application filed.		Name.	Locality.		Delivery of carp.	
	Date.	Number.		Post-office.	County.	Date.	Number.
920	Jan. 8, 1880	2646	J. W. Dorsey	New Market	Frederick	Jan. 8, 1880	20
921	Jan. 8, 1880	2644	J. W. Downey	do	do	Jan. 8, 1880	20
922	Jan. 8, 1880	2643	William Downey	do	do	Jan. 8, 1880	20
923	Jan. 8, 1880	2648	Howard H. Hopkins	do	do	Jan. 8, 1880	20
924	Jan. 8, 1880	2647	John D. Shearer	do	do	Jan. 8, 1880	20
925	Jan. 8, 1880	2642	Mrs. E. C. Shipley	do	do	Jan. 8, 1880	20
926	Dec. 11, 1879	2612	Eliza Swormley	do	do	Dec. 11, 1879	20
927			William E. Swormley	do	do	Nov. 11, 1880	50
928	Nov. 19, 1880	2829	Thomas D. Bond	Point of Rocks	do	Nov. 19, 1880	40
929	Dec. 20, 1880	3223	Benjamin Moffett	do	do	Dec. 20, 1880	75
930	Nov. 19, 1880	2827	George Souder	Lander	do	Nov. 19, 1880	50
931			William G. Wilson	Unionville	do	Mar. 23, 1881	50
932	Dec. —, 1880	5247	L. E. Hinks	Urbana	do	May 28, 1881	40
933	Dec. 1, 1880	3028	Hugh McAleer	Walkersville	do	Dec. 1, 1880	75
934	Dec. 23, 1879	2631	William C. Needig	do	do	Dec. 23, 1879	20
935	Dec. 23, 1879	2632	W. N. Todd	do	do	Dec. 23, 1879	20
936	Dec. 23, 1879	2632	do	do	do	Feb. 1, 1881	50
937	Dec. 6, 1879	2586	Henry Kupman	Woodsborough	do	Dec. 6, 1879	20
938	Apr. 12, 1880	1721	J. L. McCommas	Oakland	Garrett	Nov. 11, 1880	
939	Nov. 17, 1880	2803	F. Lewis Ruppert	do	do	Nov. 17, 1880	50
940	Feb. 7, 1880	2667	John H. Orem	Aberdeen	Harford	Feb. 7, 1880	20
941			H. W. Archer	Bel Air	do	May 7, 1880	20
942			S. Archer	do	do	May 7, 1880	20
943			L. Cahn	do	do	May 7, 1880	20
944			John Clayman	do	do	May 7, 1880	20
945			John S. Dallam	do	do	May 7, 1880	20
946			P. Donnegan	do	do	May 7, 1880	20
947			William S. Forward	do	do	May 7, 1880	20
948			Alexander Fulford	do	do	May 10, 1880	20
949	Jan. 27, 1882	8639	do	do	do	Jan. 27, 1881	50
950	Jan. 30, 1880	2666	B. Howard	do	do	Jan. 30, 1880	20
951			P. Howard	do	do	May 7, 1880	20
952			Andrew Katzmier	do	do	May 10, 1880	20
953			Geo. Y. Maynadyer	do	do	May 7, 1880	20
954			William S. Richardson	do	do	May 7, 1880	20
955			H. Stump	do	do	May 7, 1880	20
956	Nov. 2, 1880	2703	Alexander M. Tulford	do	do	Nov. 2, 1880	50
957			G. L. Van Bibber	do	do	May 7, 1880	20
958			E. H. Webster	do	do	Jan. 7, 1880	20
959			William Gladden	Chrome Hill	do	Nov. 17, 1880	50
960	Feb. 2, 1881	2801	do	do	do	Feb. 2, 1881	50
961	Dec. 16, 1881	2697	Andrew Reynolds	Forest Hill	do	Oct. 30, 1880	50
962	Oct. 30, 1880	2696	Rae Tucker	do	do	Oct. 30, 1880	50
963	Nov. 22, 1881	8633	John Street	Hickory	do	Feb. 10, 1880	20
964	Dec. 10, 1879	2608	Charles T. Scarff	Pleasantville	do	Dec. 10, 1879	20
965	Dec. 10, 1879	2608	do	do	do	Dec. 24, 1880	150
966	Dec. 10, 1879	2607	Samuel G. Scarff	do	do	Dec. 10, 1879	20
967	Feb. 10, 1880	2668	A. M. Emory	Taylor	do	Feb. 10, 1880	20
968	Feb. 10, 1880	2668	do	do	do	Nov. 10, 1880	40
969	Nov. 12, 1881	2478	Dr. R. Emory	do	do	Nov. 10, 1879	20
970	May 6, 1881	8625	E. Stanley Rodgers	The Rocks	do	May 6, 1881	100
971	Mar. 19, 1881	8638	Harry Ashley	Upper X-Roads	do	Mar. 19, 1881	50
972	Nov. 16, 1880	2798	Joseph Ashton	do	do	Nov. 16, 1880	50
973	Jan. 15, 1881	8673	Joseph E. Ashton	do	do	Jan. 15, 1881	150
974	Mar. 19, 1881	8636	St. Clear Ashton	do	do	Mar. 19, 1881	50
975	Nov. 16, 1880	2797	St. Clair Baldwin	do	do	Nov. 16, 1880	50
976	Nov. 16, 1880	2796	William Baldwin	do	do	Nov. 16, 1880	50
977	Nov. 17, 1879	2503	James D. Ball	do	do	Nov. 17, 1879	20
978	Nov. 17, 1879	2503	do	do	do	Nov. 27, 1880	50
979	Dec. 16, 1881	8628	James Ball	do	do	Nov. 27, 1880	50
980	Dec. 24, 1880	3257	John B. Banister	do	do	Dec. 24, 1880	100
981	Mar. 11, 1881	4429	Benjamin Dixon	do	do	May 26, 1881	50
982	Nov. 13, 1879	2498	Joseph Hayghe	do	do	Nov. 13, 1879	20
983	Nov. 13, 1879	2498	do	do	do	Dec. 6, 1880	50
984	Jan. 15, 1881	8640	Edward Lancaster	do	do	Jan. 15, 1881	150
985			William Phillips	do	do	Mar. 26, 1881	50
986			Charles T. Scarff	do	do	Dec. 24, 1880	150
987	Nov. 19, 1879	2510	W. A. Spencer	do	do	Nov. 19, 1879	20
988			Joseph Whittle	do	do	Mar. 19, 1881	50
989	Apr. 15, 1881	8647	Elizabeth D. Keech	Clarksville	Howard	Apr. 15, 1881	50
990			James Harban	Dayton	do	May 10, 1880	20
991	Nov. 10, 1880	2735	do	do	do	Nov. 10, 1880	50
992	Nov. 14, 1879	2499	Marcus W. Brown	Ellicott City	do	Nov. 14, 1879	20
993	Nov. 29, 1880	3021	John R. Clarke	do	do	Nov. 29, 1880	50
994			W. A. Hammond	do	do	May 7, 1880	20
995	Feb. 11, 1881	8646	D. C. Kefawver	do	do	Feb. 11, 1881	50

Table showing by States the final destination of carp distributed, &c.—Continued.

MARYLAND—Continued.

Serial number.	Application filed.		Name.	Locality.		Delivery of carp.	
	Date.	Number.		Post-office.	County.	Date.	Number.
996	May 11, 1880	1930	J. D. McGuire	Ellicott City	Howard	—— —, 1880	20
997	Apr. 1, 1881	8649	William A. Ridgely	Glenwood	do	Apr. 1, 1881	50
998	Nov. 11, 1880	2747	B. G. Cissel	Highland	do	Nov. 11, 1880	50
999			Samuel Hopkins	do	do	May 13, 1880	10
1000	Dec. 26, 1881	8643	do	do	do	Apr. 25, 1881	25
1001	Nov. 3, 1880	2708	W. Mackintosh	Elk Ridge Landing.	do	Nov. 3, 1880	50
1002			W. Merrich	Ilchester	do	Apr. 27, 1881	50
1003			John W. Quick	Oakland Mills	do	May 10, 1880	20
1004	Nov. 12, 1880	2766	John T. Roston	West Friendship.	do	Nov. 12, 1880	50
1005	Apr. 9, 1881	8648	John R. Brown	Woodstock	do	Apr. 9, 1881	50
1006	Nov. 12, 1880	2767	Samuel E. Davis	do	do	Nov. 12, 1880	50
1007	Dec. 8 1880	3037	L. C. Justis, jr	Kennedyville	Kent	Dec. 8, 1880	75
1008	Nov. 19, 1879	2513	Wm. W. McKnett	do	do	Nov. 19, 1879	20
1009	—— —, 1881	8876	Samuel Casey	Massey	do	Jan. 11, 1881	38
1010	Nov. 11, 1880	2749	W. B. Harboard	Still Pond	do	Nov. 11, 1880	50
1011	Nov. 11, 1880	2748	J. W. Howard	do	do	Nov. 11, 1880	50
1012			George R. Parrott	do	do	—— —, 1880	
1013			F. L. E. Fletcher		Montgomery	Nov. 12, 1880	40
1114			M. W. P. Miller		do	Nov. 1, 1880	20
1015			B. T. Palmer		do	Nov. 23, 1880	20
1016			James Parker		do	Nov. 30, 1880	50
1017	Oct. 25, 1880	2420	William O. Sellman	Barnesville	do	Nov. 12, 1880	
1018	Nov. 12, 1880	2769	Leonidas Jones	Beallsville	do	Nov. 12, 1880	50
1019	Nov. 12, 1880	2770	Willis O. Rhodes	do	do	Nov. 12, 1880	50
1020	Nov. 16, 1880	2785	Samuel Janney	Brighton	do	Nov. 16, 1880	50
1021	Nov. 16, 1880	2786	H. T. Lea	do	do	Nov. 16, 1880	50
1022	May 2, 1881	4428	J. D. W. Moore	Cabin John	do	May 15, 1881	20
1023	Oct. 20, 1880	5420	George V. Balch	Dawsonville	do	Nov. 1, 1880	20
1024	Dec. 15, 1880	3243	George R. Hays	Dickerson	do	Dec. 15, 1880	50
1025	Nov. 19, 1880	2828	Harry D. Cook	Gaithersburgh	do	Nov. 19, 1880	40
1026	Nov. 19, 1879	2512	W. A. Cooke	do	do	Nov. 19, 1879	20
1027			E. L. Tschiffely	Hunting Hill	do	Nov. 13, 1879	20
1028	May 3, 1880	1843	do	do	do	Nov. 10, 1880	40
1029			C. B. Calvert	Linden	do	May 17, 1880	10
1030			Miss E. A. Calvert	do	do	May 17, 1880	10
1031	Dec. 15, 1880	3245	Otho T. Hays	Monocacy	do	Dec. 15, 1880	50
1032	Dec. 15, 1880	3244	David L. Specht	do	do	Dec. 15, 1880	50
1033	Nov. 16, 1880	2791	Robert M. Mackall	Olney	do	Nov, 16, 1880	50
1034	Oct. 22, 1880	5423	John T. Fletchall	Poolesville	do	Nov. 10, 1880	40
1035			do	do	do	Apr. 19, 1881	40
1036	Nov. 12, 1880	2756	George W. Spates	do	do	Nov. 12, 1880	
1037	Oct. 22, 1880	5422	do	do	do	Nov. —, 1880	100
1038	Nov. 12, 1880	2757	Benjamin White	do	do	Nov. 12, 1880	
1039	Oct. 22, 1880	5421	do	do	do	Nov. —, 1880	
1040	Apr. 27, 1881	8658	J. R. Bartlett	Sandy Spring	do	Apr. 27, 1881	50
1041	Nov. 16, 1880	2799	Charles F. Brooke	do	do	Nov. 1, 1880	20
1042			do	do	do	May 20, 1880	10
1043	Nov. 16, 1880	2799	do	do	do	Nov. 16, 1880	50
1044		8661	Frank Gilpin	do	do	Apr. 27, 1881	50
1045	Nov. 16, 1880	2784	Henry C. Hallowell	do	do	Nov. 16, 1880	50
1046			Francis Miller	do	do	Nov. 16, 1880	50
1047	Nov. 16, 1880	2789	Henry H. Miller	do	do	Nov. 16, 1880	50
1048	June 9, 1880	2060	Benjamin D. Palmer	do	do	Nov. 16, 1880	50
1049			R. M. Stabler	do	do	Apr. 19, 1881	25
1050			Charles Reighter	Spencerville	do	Mar. 8, 1881	20
1051	Jan. 12, 1880	2650	do	do	do	Jan. 12, 1880	20
1052	Nov. 16, 1880	2790	Warwick P. Miller	do	do	Nov. 16, 1880	50
1053	Nov. 16, 1880	2794	Asa M. Stabler	do	do	Nov. 16, 1880	50
1054	Nov. 10, 1880	2431	Caleb Stabler	do	do	Nov. 16, 1880	50
1055	Nov. 16, 1880	2793	Robert M. Stabler	do	do	Nov. 16, 1880	50
1056	Feb. 20, 1880	1387	Aug. W. Smith	Wheaton	do	Oct. 28, 1880	
1057		1387	do	do	do	May 7, 1881	25
1058			Daniel Ammen	Beltsville	Pr'ce George's	Nov. 19, 1880	20
1059	Nov. 8, 1880	2451	F. A. Tschiffely, jr	do	do	Jan. 10, 1881	20
1060	Apr. 24, 1880	1845	Jacob Lerch	Forestville	do	Nov. 20, 1880	20
1061	Nov. 9, 1880	2725	James M. Hawkins	Laurel	do	Nov. 9, 1880	50
1062	Mar. 5, 1880	1489	Miss E. A. Calvert	Rosaryville	do	Dec. 24, 1880	75
1063	Dec. —, 1880	5245	James E. Bailey	Centreville	Queen Anne	Dec. —, 1880	40
1064	Nov. 16, 1880	3006	John M. Collins	do	do	Nov. 16, 1880	40
1065	Dec. 16, 1879	2621	Samuel T. Earle	do	do	Dec. 16, 1879	20
1066	Dec. 16, 1879	2621	do	do	do	Nov. 12, 1880	40
1067	Aug. 24, 1880	2216	Richard Hollyday	do	do	Nov. 19, 1879	80
1068	Aug. 24, 1880	2216	do	do	do	Dec. 23, 1880	40

Table showing by States the final destination of carp distributed, &c.—Continued.

MARYLAND—Continued.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
1069	Nov. 12, 1880	3004	Washington Finley	Church Hill	Queen Anne	Nov. 12, 1880	40
1070	....	....	Allen M. Wilson	Queenstown	....do	May 28, 1881	20
1071	....	....	John McFadden	Sudlersville	....do	Dec. —, 1880	5
1072	Dec. 23, 1880	3256	W. H. Neal	....do	....do	Dec. 23, 1880	110
1073	Dec. 18, 1880	3248	J. E. F. Shane	Charlotte Hall	Saint Mary's	Dec. 18, 1880	150
1074	Dec. 18, 1880	3246	Theodore Smoot	....do	....do	Dec. 18, 1880	150
1075	Dec. 18, 1880	3249	Fred. J. Wiley	....do	....do	Dec. 18, 1880	150
1076	Oct. 19, 1880	2402	George R. Dennis	Kingston	Somerset	Nov. 15, 1880	......
1077	Aug. 24, 1880	2219	Levin L. Waters	Princess Anne	....do	Nov. 12, 1880	40
1078	Aug. 24, 1880	2220	Levin Woolford	....do	....do	Nov. 12, 1880	40
1079	Aug. 24, 1880	2218	Dr. I. L. Adkins	Easton	Talbot	Nov. 12, 1880	40
1080	Nov. 23, 1880	3232	A. C. Buchanan	....do	....do	Nov. 23, 1880	40
1081	Dec. 16, 1879	2620	P. Onier Cherbonier	....do	....do	Dec. 16, 1879	20
1082	Dec. 8, 1880	3240	....do	....do	....do	Dec. 8, 1880	40
1083	Nov. 23, 1880	3229	W. H. Hollyday	....do	....do	Nov. 23, 1880	40
1084	Mar. 20, 1879	703	Thomas Hughlett	....do	....do	Nov. 11, 1880	1000
1085	Mar. 20, 1879	703	....do	....do	....do	Nov. 7, 1879	128
1086	Mar. 20, 1879	703	....do	....do	....do	Nov. 19, 1879	100
1087	Mar. 20, 1879	703	....do	....do	....do	Dec. 4, 1879	90
1088	Mar. 20, 1879	703	....do	....do	....do	Nov. 21, 1879	292
1089	Mar. 20, 1879	703	....do	....do	....do	Nov. 22, 1879	86
1090	Mar. 20, 1879	703	....do	....do	....do	Dec. 15, 1879	100
1091	Mar. 20, 1879	703	....do	....do	....do	Dec. 18, 1880	1000
1092	Dec. 21, 1880	3253	Charles E. Shanahan	....do	....do	Dec. 21, 1880	40
1093	....	....	Jas. E. Tarbutton	Hambleton	....do	Nov. 8, 1879	16
1094	Oct. 19, 1880	2403	....do	....do	....do	Nov. 15, 1880	40
1095	Nov. 7, 1879	2484	William T. Elben	Longwoods	....do	Nov. 8, 1879	20
1096	Nov. 8, 1879	2488	A B Hardcastle	Skipton	....do	Nov. 8, 1879	16
1097	Nov. —, 1880	5252	T. Hopkins	....do	....do	Nov. —, 1880	40
1098	Oct. 19, 1880	2404	John H. Allen	Trappe	....do	Nov. 15, 1880	40
1099	Nov. 8, 1879	2487	J. Thos. Bartlett	....do	....do	Nov. 8, 1879	16
1100	Apr. 8, 1881	3983	William Collins	....do	....do	Nov. 8, 1879	16
1101	Oct. 19, 1880	2405	....do	....do	....do	Nov. 15, 1880	40
1102	Dec. —, 1880	5250	William R. Hughlett	....do	....do	May 28, 1881	40
1103	Nov. 5, 1879	2486	William P. Wright	....do	....do	Nov. 8, 1879	16
1104	Aug. 24, 1880	2217	A. Jeffrey	Tunis Mills	....do	Nov. 12, 1880	40
1105	May 19, 1880	1969	Col. Edward Lloyd	....do	....do	Nov. 8, 1879	16
1105½	Aug. 24, 1880	2221	do	....do	....do	Nov. 12, 1880	40
1106	Nov. 23, 1880	3228	H. B. Robinson	....do	....do	Nov. 23, 1880	40
1107	May 20, 1880	1983	W. W. Tunis & Bro	....do	....do	Nov. 12, 1880	40
1108	Aug. 24, 1880	2223	Theophilus Tunis	....do	....do	Nov. 12, 1880	40
1109	Nov. 25, 1881	2489	John R. Hopkins	Wye Mills	....do	Nov. 8, 1879	16
1110	Mar. 28, 1881	8825	John D. Wisherd	Benevola	Washington	Mar. 28, 1881	50
1111	Mar. 28, 1881	8826	Jacob Dick	Beaver Creek	....do	Mar. 28, 1881	50
1112	....	....	Martin Emmert	Breathedsville	....do	Mar. 12, 1881	50
1113	Mar. 22, 1881	8827	David H. Newcomer	Benevola	....do	Mar. 22, 1881	75
1114	Dec. 20, 1880	3226	Daniel Wolf	Fair Play	....do	Dec. 20, 1880	75
1115	Oct. 30, 1880	2695	E. H. Frantz	Clear Spring	....do	Oct. 30, 1880	50
1116	....	....	Oden Bowie	Fairview	....do	Nov. 24, 1879	50
1117	May —, 1881	4641	H. C. Loose	Hagerstown	....do	May —, 1881	50
1118	Dec. 1, 1880	3029	J. E. Holmes	Rohrersville	....do	Dec. 1, 1880	......
1119	Nov. 27, 1881	8821	Jonas Bell	Williamsport	....do	Nov. 27, 1881	40
1120	Nov. —, 1880	5251	L. J. Timmons	Pittsville	Wicomico	Nov. —, 1880	40
1121	Nov. 19, 1880	3014	Humph. Humphreys	Salisbury	....do	Nov. 19, 1880	40
1122	Nov. 23, 1880	3230	George W. Parsons	....do	....do	Nov. 23, 1880	40
1123	Dec. 7, 1880	3235	Joshua E. Carey	Berlin	Worcester	Dec. 7, 1880	40
1124	Aug. 24, 1880	2222	Lee Carey	....do	....do	Nov. 12, 1880	40
1125	Dec. 7, 1880	3239	Frank Henry	....do	....do	Dec. 7, 1880	40
1126	May 21, 1880	1986	George W. Henry	....do	....do	Nov. 25, 1880	40
1127	Dec. 7, 1880	3238	James P. Henry	....do	....do	Dec. 7, 1880	40
1128	....	....	Dr. William Henry	....do	....do	Dec. 28, 1880	100
1129	Dec. 7, 1880	3236	Zadok P. Henry	....do	....do	Dec. 7, 1880	40
1130	May 21, 1880	1989	William D. Petts	....do	....do	Nov. 23, 1880	40
1131	May 21, 1880	1988	John W. Pitts, M. D	....do	....do	Nov. 23, 1880	40
1132	Dec. 7, 1880	3237	Charles Richardson	....do	....do	Dec. 7, 1880	40
1133	Nov. 23, 1880	3231	Lemuel Showell	....do	....do	Nov. 23, 1880	40

MASSACHUSETTS.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
1134	Feb. 16, 1880	1286	William E. Corson	Alford	Berkshire	Oct. 26, 1880	......
1135	June 10, 1880	2062	Zenas M. Crane	Dalton	....do	Jan. 31, 1881	77
1136	June 23, 1880	2125	John Birkenhead	Mansfield	Bristol	Oct. 29, 1880	15
1137	July 5, 1880	2227	Oliver Ames	North Easton	....do	Nov. 1, 1880	15

Table showing by States the final destination of carp distributed, &c.—Continued.

MASSACHUSETTS—Continued.

Serial number.	Application filed.		Name.	Locality.		Delivery of carp.	
	Date.	Number.		Post-office.	County.	Date.	Number.
1138	July 10, 1880	2159	Daniel L. Mitchell	Taunton	Bristol	Oct. 26, 1880	15
1139	Apr. 6, 1880	1605	Sydney Harris	Chilmark	Dukes	Oct. 26, 1880	...
1140	Mar. —, ——	1567	John A. Blake	Ipswich	Essex	Nov. 1, 1880	15
1141	Mar. —, ——	1567½	Albert P. Jordan	do	do	Nov. 1, 1880	15
1142	Nov. 26, 1880	2892	E. J. Thompson	Lynn	do	Nov. 26, 1880 Dec. 3, 1880	40
1143	June 5, 1879	795	Charles T. Jenkins	Salem	do	Oct. 15, 1880	15
1144	Feb. 7, 1880	1308	Lemuel Harris	Charlemont	Franklin	Nov. 5, 1880	15
1145	Apr. 10, 1880	1755	James S. Grinnell	Greenfield	do	Nov. 3, 1880	15
1146	Aug. 18, 1880	2210	James W. Hannum	Ludlow	Hampden	Oct. 26, 1880	15
1147	Jan. 8, 1880	2053	E. Morgan	Springfield	do	Oct. 26, 1880	15
1148	Nov. 29, 1880	2883	J. M. Thompson	do	do	Dec. 23, 1880	20
1149	Jan. 9, 1880	1094	H. L. Loomis	Westfield	do	Nov. 4, 1880	15
1150	Aug. 25, 1879	855	Wm. F. Martindale	Enfield	Hampshire	Nov. 4, 1880	15
1151	Apr. 22, 1880	1766	Hiram Packard	Goshen	do	Nov. 4, 1880	15
1152	Nov. 1, 1880	3012	Hiram Farrington	Holliston	Middlesex	Nov. 1, 1880	15
1153	Sept. 21, 1880	2363	H. Fish Committee	do	do	Oct. 26, 1880	50
1154	Feb. 16, 1880	1199	Howard M. Munroe	Lexington	do	Nov. 1, 1880	15
1155	Mar. 22, 1880	1598	Edward A. Brackett	Winchester	do	Oct. —, 1880	1,300
1156	Sept. —, 1880	2343	William Claflin	Newtonvile	do	Nov. 30, 1880	20
1157	Aug. 28, 1880	2408	Walter H. Knight	South Framingham.	do	Nov. —, 1880	15
1158	Nov. —, 1880	3011	Leonard Huntress	Tewksbury	do	Nov. —, 1880	15
1159	Dec. 22, 1879	1046	William Perham	Tyngsborough	do	Nov. 1, 1880	15
1160	......	......	James Carter	Wakefield	do	Nov. 1, 1880	20
1161	Aug. 3, 1880	2197	Reuben J. Butterfield	West Chelmsford.	do	Oct. 26, 1880	20
1162	July 2, 1880	2140	Burton Hatheway	Islington	Norfolk	Oct. 26, 1880	......
1163	Jan. 19, 1880	1195	H. C. Stark	Hyde Park	do	Nov. 1, 1880	20
1164	Mar. 15, 1880	1573	George C. McIntosh	Needham	do	Nov. 11, 1880	15
1165	July 1, 1880	2133	Frank E. Horton	Plainville	do	Oct. 26, 1880	20
1166	Feb. 13, 1880	1317	Francis E. Loud	Weymouth	do	Oct. 29, 1880	15
1167	Oct. 26, 1880	5425	W. Blake Everett	Boston	Suffolk	Oct. 26, 1880	......
1168	May 23, 1879	772	E. J. Carpenter	do	do	Oct. 26, 1880	......
1169	Feb. 28, 1880	1376	George H. Richards	do	do	Nov. 8, 1880	15
1170	......	......	G. A. Sammit	do	do	Dec. 15, 1880	20
1171	Dec. 1, 1879	981	John L. Shorey	do	do	Oct. 30, 1880	15
1172	July 11, 1878	389	B. F. Whettemore	do	do	Oct. 26, 1880	......
1173	Apr. 26, 1880	1814	Thomas S. Peers	East Brookfield.	Worcester	Oct. 30, 1880	15
1174	June 28, 1880	2105	Martin Green	Green Hill*	do	Nov. —, 1880	15
1175	Apr. 2, 1880	1694	Sumner Clark	Leominster	do	Nov. 10, 1880	15
1176	May 13, 1880	1942	J. A. George	Mendon	do	Oct. 26, 1880	......
1777	Jan. 14, 1880	1248	Dr. D. Russell	Milford	do	Nov. 1, 1880	15
1178	Jan. 2, 1880	1104	C. H. Lawrence	South Lancaster.	do	Nov. 1, 1880	15
1179	Apr. 23, 1880	1778	Arthur C. Moore	Sturbridge	do	Oct. 26, 1880	......

MICHIGAN.

Serial number.	Application date.	Application number.	Name.	Post-office.	County.	Delivery date.	Delivery number.
1180	Apr. 8, 1880	1611	Mrs. M. E. Taylor	Hastings	Barry	Nov. —, 1880	16
1181	Sept. 22, 1880	2365	Samuel McGuigan	Benton Harbor	Berrien	Nov. 4, 1880	......
1182	June 12, 1880	2123	H. A. Portman	do	do	Jan. 6, 1881	16
1183	......	......	C. C. Sutton	Millburg	do	Nov. 27, 1880	16
1184	May 31, 1880	2118	Junius H. Hatch	Saint Joseph	do	Jan. 6, 1881	16
1185	......	......	M. Metcalfe	Battle Creek	Calhoun	Nov. 19, 1880	16
1186	Nov. 4, 1880	2429	do	do	do	Dec. —, 1880	20
1187	......	......	Alonzo Garwood	Cassopolis	Cass	Nov. 23, 1880	16
1188	June 5, 1880	2121	do	do	do	Dec. —, 1880	20
1189	Jan. 14, 1880	1119	Sumner Howard	Flint	Genesee	Nov. 20, 1880	16
1190	July 15, 1880	2171	J. A. Hubbell	Houghton	Houghton	Oct. 29, 1880	363
1191	Mar. 22, 1880	1606	Alonzo S. Hume	Medina	Lenawee	Nov. —, 1880	16
1192	Nov. 16, 1880	3161	do	do	do	Nov. 16, 1880	16
1193	Dec. 1, 1880	2897	A. R. Hume	Morenci	do	Nov. —, 1880	......
1194	Apr. 3, 1880	1659	S. Alexander	Birmingham	Oakland	Nov. 9, 1880	16
1195	Mar. 22, 1880	1536	John W. Curtis	Klinger's Lake	Saint Joseph	Dec. 3, 1880	16
1196	May 7, 1880	2117	C. Engle	Paw Paw	Van Buren	Nov. —, 1880	25
1197	June 13, 1880	2073	A. J. Kellogg	Detroit	Wayne	Nov. 4, 1880	......
1198	Nov. 6, 1880	2721	Frank N. Clark	Northville	do	Nov. 6, 1880	700

*Worcester P. O.

Table showing by States the final destination of carp distributed, &c.—Continued.

MINNESOTA.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
1199	Oct. 21, 1880	3003*	John Froshany	Lake Park	Becker	Oct. 21, 1880	15
1200	Mar. 29, 1880	1542	C. S. Day	Hawley	Clay	Oct. 25, 1880	15
1201	Apr. 11, 1881	3984	L. Z. Rogers	Waterville	Le Sueur	Apr. 18, 1881	25
1202	Sept. 9, 1878	463	R. O. Sweeny	Saint Paul	Ramsey	Oct. 6, 1880	500
1203	—— —, 1880	1369	R. H. L. Jewett	Faribault	Rice	Oct. 6, 1880	15
1204	Mar. 1, 1880	1437	John Fisher	Stillwater	Washington	Oct. 9, 1880	15
1205	Apr. 3, 1880	1671	J. R. McLean	Saint James	Watonwan	Oct. 29, 1880	15
1206	July 7, 1880	2153	H. C. D. Ordoroff	Monticello	Wright	Oct. 31, 1880	15

MISSISSIPPI.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
1207	Feb. 16, 1880	746	G. W. Crowder	Kosciusko	Attala	Dec. 17, 1880	......
1208	Feb. 21, 1881	3681	O. S. Rimmer & Son	do	do	Feb. 21, 1881	50
1209	Apr. 30, 1880	1840	S. P. Rimmer & Son	do	do	Apr. —, 1881	......
1210	Apr. 18, 1879	740	R. L. Bonton	Canaan	Benton	—— —, 1879	20
1211	Nov. 24, 1880	3055	Thomas J. Hudson	Lamar	do	Dec. 22, 1880	20
1212	Nov. 24, 1880	3056	W. L. Treadwell	do	do	Dec. 17, 1880	......
1213	May 19, 1880	1973	W. M. Woodward	New Prospect	Choctaw	Dec. 17, 1880	......
1214	Oct. 28, 1880	2435	S. E. Scarborough	De Soto	Clarke	Dec. 24, 1880	......
1215	Dec. 20, 1880	3084	F. C. McGee	Enterprise	do	Dec. —, 1880	......
1216	Nov. 23, 1880	3053	Jobe Harral	Eudora	De Soto	Dec. 18, 1880	......
1217	Dec. 21, 1880	3105	T. White	Hernando	do	Dec. 21, 1880	......
1218	Dec. 21, 1880	3106	John P. Withers	do	do	Dec. 21, 1880	......
1219	Dec. 21, 1880	3108	R. B. Bowie	Horn Lake	do	Dec. 21, 1880	......
1220	Nov. 24, 1880	3054	L. W. Gabbert	do	do	Dec. 17, 1880	......
1221	July 14, 1878	489	E. R. Brown	Hazlehurst	Copiah	—— —, 1880	20
1222	May 13, 1878	342	do	do	do	Dec. 22, 1880	20
1223	June 14, 1880	2077	E. G. Peyton	do	do	Dec. 22, 1880	20
1224	June 19, 1880	2087	C. W. Barber	Edwards' Depot.	Hinds	Dec. —, 1880	20
1225	....	......	M. F. Ash	Jackson	do	Dec. —, 1880	10
1226	....	......	Thomas Atkinson	do	do	Dec. —, 1880	20
1227	July 20, 1880	2181	P. T. Baley	do	do	Dec. 31, 1880	20
1228	Nov. 18, 1879	2504	Thomas E. Helm	do	do	Nov. 18, 1879	20
1229	....	......	Wm. L. Hennequery	do	do	Dec. —, 1880	20
1230	Dec. —, 1880	5176	W. T. Holland	do	do	Dec. —, 1880	17
1231	May 8, 1882	13591	A. N. Kimball	do	do	Dec. —, 1880	20
1232	Dec. —, 1880	5175	D. P. Porter	do	do	Dec. —, 1880	8
1233	Dec. —, 1880	5160	S. A. Wamsley	do	do	Dec. —, 1880	12
1234	Dec. 20, 1880	3087	Col. Hamilton	Durant	Holmes	Dec. —, 1880	......
1235	Apr. 28, 1880	1774	R. P. Heffner	West	do	Dec. —, 1880	50
1236	June 27, 1880	2102	I. W. Burch	Stonington	Jefferson	Jan. 16, 1881	20
1237	June 28, 1880	2104	Put. Darden	Fayette	do	Jan. 15, 1881	30
1238	Apr. 24, 1880	1883	R. G. Caldwell	Scooba	Kemper	—— —, 1880	......
1239	Apr. 22, 1880	1878	H. M. Duke	do	do	Dec. 30, 1880	200
1240	Apr. 22, 1880	1879	James Haughey	do	do	—— —, 1880	......
1241	Apr. 23, 1880	1880	A. M. Moore	do	do	—— —, 1880	......
1242	Apr. 23, 1880	1881	W. A. Moseley	do	do	—— —, 1880	......
1243	Apr. 24, 1880	1884	William Nevill, jr	do	do	—— —, 1880	......
1244	Apr. 23, 1880	1882	T. W. Pervin	do	do	—— —, 1880	......
1245	Apr. 27, 1880	1890	H. T. Williamson	do	do	—— —, 1880	......
1246	May 1, 1880	1894	J. F. Jenkins	Wahalak	do	—— —, 1880	......
1247	Feb. 8, 1878	642	W. N. Shive	Abbeville	La Fayette	Dec. 17, 1880	......
1248	Mar. 1, 1880	1521	William D. Holder	Oxford	do	Dec. 17, 1880	......
1249	Nov. 19, 1880	3047	N. J. Lawhorn	do	do	Dec. 20, 1880	......
1250	Apr. 26, 1879	739	Mr. Sneed	do	do	Dec. 17, 1880	20
1251	Nov. 19, 1880	3047½	W. V. Sneed	do	do	Dec. 20, 1880	20
1252	May —, 1879	741	B. F. Archer	Taylor	do	Nov. 20, 1879	50
1253	Nov. 17, 1880	5415	A. L. Burwell	Meridian	Lauderdale	Dec. 24, 1880	......
1254	Apr. 22, 1878	234	John W. Fewell	do	do	—— —, 1879	20
1255	May 19, 1880	1970	W. F. McLemore	do	do	Dec. 24, 1880	......
1256	Nov. 17, 1880	5413	J. R. Mitchell	do	do	Dec. 24, 1880	......
1257	Dec. 20, 1880	3086	McRae Mosby	do	do	—— —, 1880	500
1258	Nov. 11, 1880	2465	C. A. Johnston	Columbus	Lowndes	Dec. 31, 1880	100
1259	Nov. 20, 1880	5148	J. W. Ellis	Canton	Madison	Nov. —, 1880	24
1260	Dec. 20, 1880	3088	Philips & Jones	do	do	Dec. 30, 1880	50
1261	Dec. —, 1880	5172	D. R. Hearn	Madison Stat'n	do	Dec. —, 1880	14
1262	Dec. —, 1880	5171	H. E. McKay	do	do	Dec. —, 1880	8
1263	Dec. —, 1880	5173	A. Perkins	do	do	Dec. —, 1880	20
1264	Dec. 20, 1880	3225	S. R. White	Byhalia	Marshall	Dec. 20, 1880	20
1265	Dec. —, 1880	5185	R. B. Alexander	Holly Springs	do	Dec. —, 1880	20
1266	Nov. 12, 1881	7279	John M. Anderson	do	do	Dec. —, 1880	15
1267	Dec. 21, 1880	3123	Frank Cannon	do	do	Dec. 20, 1880	20
1268	Dec. —, 1880	5178	W. W. Cock	Hudsonville	do	Dec. —, 1880	20
1269	Dec. —, 1880	5181	C. M. Cooper	Holly Springs	do	Dec. —, 1880	20

* Also Number 2242.

Table showing by States the final destination of carp distributed, &c.—Continued.

MISSISSIPPI—Continued.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
1270	Dec. —, 1880	5184	Mrs. E. W. Green	Holly Springs	Marshall	Dec. —, 1880	20
1271	Dec. —, 1880	5183	M. C. Knapp	do	do	Dec. —, 1880	20
1272	Nov. 20, 1879	2525	Robert McGowan	do	do	Nov. 20, 1879	235
1273	Nov. 20, 1881	5182	M. J. McKinney	do	do	Dec. —, 1880	20
1274	Dec. —, 1880	5179	J. R. Mahone	do	do	Dec. —, 1880	20
1275	Apr. 26, 1879	738	Van H. Manning	do	do	Dec. 17, 1880	.....
1276	——, 1881	11165	T. S. Richmond	do	do	Dec. —, 1880	20
1277	Dec. —, 1880	5187	W. A. Roberts	do	do	Dec. —, 1880	20
1278	Dec. 20, 1880	3224	Wallace & McGowan	do	do	Dec. 20, 1880	688
1279	Dec. —, 1880	5180	A. M. West	do	do	Dec. —, 1880	20
1280	Dec. 21, 1880	3124	Shelton White	do	do	Dec. —, 1880	20
1281	Dec. 21, 1880	3122	A. Q. Withers	do	do	Dec. 20, 1880	20
1282	Dec. —, 1880	5188	H. H. Wood	do	do	Dec. —, 1880	20
1283	Dec. —, 1880	5164	F. H. Joy	Mt. Pleasant	do	Dec. —, 1880	10
1284	Dec. —, 1880	5152	Jones M. Brooks	Waterford	do	Dec. —, 1880	20
1285	Mar. —, 1881	3757	J. Z. George	Winona	Montgomery	Mar. 9, 1881	50
1286	Apr. 28, 1849	742	H. D. Money	do	do	—— —, 1879	20
1287	Apr. 28, 1879	742	....	do	do	Dec. 12, 1879	100
1288	Jan. 24, 1879	627*	Eugene Carleton	Decatur	Newton	—— —, 1879	20
1289	Dec. —, 1879	1015	R. Doolittle	do	do	Dec. 23, 1880	15
1290	Jan. 24, 1879	629	G. M. Gallaspy	do	do	—— —, 1879	20
1291	Dec. —, 1879	1016	J. W. Guthrie	do	do	Dec. 23, 1880	15
1292	May 1, 1878	343	do	do	do	Jan. 14, 1881	20
1293	Jan. 21, 1879	625	Samuel Herd	do	do	—— —, 1879	20
1294	May 1, 1878	344	M. J. L. Hoye	do	do	—— —, 1879	20
1295	Jan. 24, 1879	628	do	do	do	—— —, 1879	20
1296	Dec. —, 1879	1018	T. F. Pettus	do	do	Dec. 23, 1880	15
1297	Dec. —, 1879	1019	A. B. Watts	do	do	Dec. 23, 1880	15
1298	....	....	J. W. Guthrie	Newton	do	Dec. —, 1880	15
1299	May 29, 1880	1017	J. C. McElroy	do	do	Dec. 24, 1880	......
1300	June 1, 1880	2031	James Bryson, sr.	Macon	Noxubee	—— —, 1880	.....
1301	June 8, 1880	2056	R. G. Rives	do	do	—— —, 1881	.....
1302	May 6, 1880	1905	Samuel B. Day	Shuqualak	do	—— —, 1880	......
1303	Feb. 21, 1880	1334	H. L. Muldrow	Starkville	Oktibbeha	Dec. 3, 1880	100
1304	Dec. 21, 1880	3098	F. M. Norfleet	Como Depot	Panola	Jan. 3, 1881	20
1305	Dec. 21, 1880	3096	Monroe Pointer	do	do	Jan. 3, 1881	20
1306	Dec. 21, 1880	3100	Samuel Williamson	do	do	—— —, 1880	......
1307	Nov. 20, 1880	3049	C. W. Duval	Sardis	do	Dec. 18, 1880	......
1308	Mar. 2, 1880	1468	G. W. Dickey	Chatawa	Pike	Jan. 1, 1881	30
1309	Feb. 29, 1880	1302	W. A. Gordon	do	do	Jan. —, 1881	219
1310	Feb. 2, 1880	1391	Sisters of Notre Dame	do	do	Jan. 1, 1881	30
1311	Apr. 16, 1880	1041	Henry C. Capell	Magnolia	do	Dec. 31, 1880	30
1312	Apr. 10, 1880	1722	W. M. Conerly	do	do	Dec. 31, 1890	30
1313	Nov. 20, 1880	5144	E. McNair	do	do	Nov. —, 1880	30
1314	....	....	M. M. Whitney	Summit	do	Dec. —, 1880	20
1315	June 21, 1878	363	do	do	do	Jan. 12, 1881	20
1316	Mch. 3, 1881	3756	John Ohleyer	Brandon	Rankin	Mar. 9, 1881	50
1317	Nov. 20, 1880	5145	Hi Eastland	Forest	Scott	Nov. —, 1880	50
1318	Oct. 26, 1880	2434	W. M. Thornton	Lake	do	Dec. 23, 1880	16
1319	Nov. 23, 1880	3052	Lowrey & Berry	Blue Mountain	Tippah	Dec. 17, 1880	20
1320	Dec. 21, 1880	3117	W. A. Boyd	Ripley	do	Dec. 20, 1880	20
1321	....	....	T. A. Hunt	do	do	Dec. 20, 1880	20
1322	Dec. 21, 1880	3120	L. Ragan	do	do	Dec. 21, 1880	20
1323	Dec. 21, 1880	3119	J. C. Spight	do	do	Dec. 20, 1880	20
1324	May 22, 1879	769	Thomas Spight	do	do	—— —, 1880	20
1325	Nov. 15, 1880	5426	George D. Lawrence	Vicksburg	Warren	Dec. 17, 1880	......
1326	Dec. —, 1880	5154	J. D. Morris	do	do	Dec. —, 1880	20
1327	Dec. 20, 1880	3085	Col. Davis	Waynesboro'	Wayne	Dec. —, 1880	......
1328	Feb. 21, 1880	359	W. L. Brandon	Fort Adams	Wilkinson	Jan. 12, 1881	25
1329	May 24, 1880	2005	James Whitaker	Holly Retreat	do	—— —, 1881	......
1330	May 4, 1880	1899	Nathaniel Cropper	Woodville	do	Jan. 8, 1881	20
1331	June 8, 1880	2052	George Fuzleman	do	do	Jan. 8, 1881	20
1332	June 1, 1880	2037	E. L. McGehee	do	do	Jan. 8, 1881	20
1333	Feb. 21, 1880	175	Joseph Redhead	do	do	Jan. 10, 1881	175
1334	May 4, ——	1900	W. H. Wheat	do	do	Jan. 8, 1881	20
1335	Dec. 21, 1880	3125	R. W. Jones	Coffeeville	Yalobusha	Dec. 23, 1880	25
1336	Mar. 1, 1880	1602	C. Beauchamp	Water Valley	do	Dec. 17, 1880	......
1337	May 5, 1880	1901	Peter Johnson	do	do	Dec. 17, 1880	.....

* Also Number 385.

Table showing by States the final destination of carp distributed, &c.—Continued.

MISSOURI.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
1338	May 12, 1880	1938	Henry Murphy	Lamar	Barton	Nov. 8, 1880	......
1339	June 10, 1880	2122	E. P. Henry	Butler	Bates	Nov. 8, 1880	......
1340	Mar. 5, 1879	685	Charles Galle	Galle's Farm	Boone	Oct. 28, 1879	16
1341	June 4, 1877	71	James S. Rollins	Columbia	...do	Oct. 28, 1879	20
1342	July 4, 1881	4815	...do	...do	...do	Nov. 20, 1881	16
1343	Aug. 25, 1878	410	J. M. Proctor	Sturgeon	...do	Oct. 28, 1879	16
1344	July 12, 1880	2164	L. Clinkenbeard	Saint Joseph	Buchanan	Nov. 12, 1880	20
1345	Jan. 3, 1880	2638	Silas Woodson	...do	...do	Jan. 3, 1880	1,569
1346	Jan. 3, 1880	2638	...do	...do	...do	Nov. 11, 1880	1,179
1347	Apr 1, 1880	1687	C. G. Thwing	Hamilton	Caldwell	June 3, 1880	......
1348	June 3, 1880	2042	T. Holt	Holt's Summit	Callaway	Nov. 29, 1880	15
1349	Apr. 5, 1880	1685	John B. Feilding	East Lynne	Cass	June 3, 1880	......
1350	Mar. 2, ——	1524	J. A. Turner	Cameron	Clinton	June 3, 1880	......
1351	Mar. 29, 1880	1541	T. V. Hickox	Boonville	Cooper	June 3, 1880	15
1352	July 8, 1880	2681	Hosea Mullin	Ebenezer	Greene	July 8, 1880	8
1353	May 6, 1880	1908	...do	...do	...do	Nov. 8, 1880	......
1354	Sept. 9, 1878	449	Levi Dodge	Mound City	Holt	Oct. 28, 1879	16
1355	......	......	W. M. Hughes	Armstrong	Howard	Apr. 28, 1881	20
1356	May —, 1881	4394	J. H. Finks	Roanoke	...do	May —, 1881	20
1357	May —, 1881	4395	William Hughes	...do	...do	May —, 1881	20
1358	May —, 1881	4396	Doctor Walker	...do	...do	May —, 1881	20
1359	......	......	G. Obendorf	Kansas City	Jackson	Oct. 6, 1880	30
1360	Mar. 23, 1880	1517	T. W. Wright	...do	...do	July 8, 1881	8
1361	Apr. 26, 1880	1888	Amos Markey	Warrensburg	Johnson	Nov. 26, 1880	20
1362	Oct. 8, 1880	2394	O. D. Williams	...do	...do	Nov. 26, 1880	20
1363	Sept. 11, 1880	2353	Selden P. Williams	...do	...do	Nov. 20, 1880	20
1364	July 8, 1880	2680	B. F. Dillin	Chillicothe	Livingston	July 8, 1880	11
1364½	Mar. 29, 1880	1560	J. M. Collins	La Plata	Macon	......	......
1365	July 8, 1880	2679	...do	...do	...do	July 8, 1880	8
1366	Mar. 29, 1880	1560½	James Johnston	...do	...do	July 8, 1880	8
1367	Mar. 18, 1880	1561½	L. D. Miller	...do	...do	June 3, 1880	8
1368	Mar. 18, 1880	1557½	John P. Powell	...do	...do	July 8, 1880	8
1369	Sept. —, 1881	5911	A. S. Ray	...do	...do	July 8, 1880	8
1370	Mar. 18, 1880	1561	G. W. Sharp	...do	...do	June 3, 1880	8
1371	July 8, 1880	2678	do	...do	...do	July 8, 1880	8
1372	Mar. 18, 1880	1559½	J. M. Spencer	...do	...do	July 8, 1880	8
1373	Mar. 18, 1880	1559	H. Vandbergh	...do	...do	July 8, 1880	8
1374	June 9, 1880	2061	W. F. Williams	Macon City	...do	Nov. 8, 1880	......
1375	June 27, 1880	2103	A. B. Warner	Monroe City	Monroe	Nov. 20, 1880	20
1376	Feb. 23, 1880	1292	Henry Clark	Montgomery City.	Montgomery	July 8, 1880	9
1376½	Apr. 5, 1878	217	Horace W. Pocoke	...do	...do	......	......
1377	Oct. 30, 1879	2479	...do	...do	...do	Oct. 28, 1879	16
1378	Nov. 27, 1879	985	G. W. Varnum, M. D.	...do	...do	July 8, 1880	9
1379	Nov. 27, 1879	985	do	...do	...do	Jan. 11, 1881	9
1380	May 7, 1880	1910	I. A. Bell	Racine	Newton	July 8, 1880	9
1381	Aug. 25, 1880	2068	L. L. Bridges	Sedalia	Pettis	Nov. 17, 1880	20
1382	Jan. 29, 1880	1254	Theodore F. Warner	Platte City	Platte	June 3, 1880	......
1383	Nov. 23, 1881	568	J. R. Herford	Bridgeton	Saint Louis	Oct. 29, 1879	16
1384	Apr. 18, 1879	724	Henry Brooks	Saint Louis	...do	Oct. 28, 1879	16
1385	June 1, 1880	2032	George W. Campbell	...do	...do	Nov. 8, 1880	20
1386	June 19, 1880	2088	H. S. DePew	...do	...do	Nov. 10, 1880	20
1387	Nov. 1, 1878	561*	E. G. Eggeling	...do	...do	Oct. 29, 1879	20
1388	Aug. 24, 1877	109	H. S. Lipscomb	...do	...do	Oct. 28, 1879	16
1389	Apr. 13, 1880	1729	James J. Mead	...do	...do	Jan. 11, 1881	10
1390	......	466	O. Reid	...do	...do	Oct. 28, 1879	16
1391	Jan. —, 1877	44	Erastus Wells	...do	...do	Oct. 28, 1879	50
1392	Jan. 10, 1880	1106	Samuel McClelland	Salt Springs	Saline	June 27, 1880	8
1393	Jan. 10, 1880	1116	J. C. Keithley	Shackleford	...do	Jan. 27, 1880	16
1394	Mar. 1, 1880	1576	William A. Reid	Shelbina	Shelby	Jan. 14, 1881	20

NEBRASKA.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
1395	......	......	Kaufman & Granger	Kearney	Buffalo	May 2, 1881	25
1396	Aug. 12, 1879	861	R. R. Livingston	Plattsmouth	Cass	June 2, 1880	......
1397	Feb. 12, 1879	631	J. G. Romine	South Bend	...do	Jan. 2, 1880	......
1398	Feb. 12, 1879	631	do	...do	...do	Jan. 11, 1881	135
1399	Jan. 9, 1879	526	John G. Gasmann	Schuyler	Colfax	Jan. 2, 1880	......
1400	May 26, 1880	2011	W. L. May	Fremont	Dodge	—— —, 1880	143
1401	Dec. 19, 1881	9051	B. E. B. Kennedy	Omaha	Douglas	Dec. 19, 1881	500
1402	June 9, 1880	2058	Jay Burrows	Mellroy	Gage	Nov. 24, 1880	20
1403	Apr. 3, 1880	1874	Theodore DeVry	Saint Paul	Howard	Nov. 8, 1880	......
1404	Oct. 24, 1880	5414	...do	...do	...do	Nov. 9, 1880	......

* Also Number 266.

Table showing by States the final destination of carp distributed, &c.—Continued.

NEBRASKA—Continued.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
1405	May 18, 1880	1961	W. Hargraves	Tecumseh	Johnson	Nov. 30, 1880	20
1406	July 14, 1880	2169	John A. Edy	Hickman	Lancaster	Nov. 8, 1880	......
1407	May 1, 1880	1895	I. M. Johnson	West's Mill	Seward	Nov. 8, 1880	......
1408	Dec. 15, 1877	147	H. S. Kaley	Red Cloud	Webster	Jan. 24, 1880	140

NEW HAMPSHIRE.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
1409	July 28, 1880	2230	Aug. Eastman	North Conway	Carroll	Nov. 24, 1880	15
1410	Mar. 12, 1880	1548	Stillman S. Hutchinson.	Milford	Hillsborough	Nov. —, 1880	15
1411	Apr. 20, 1880	1739	Fred. A. Platts	Wilson's Crossing.	Rockingham	Oct. 26, 1880	......
1412	Feb. 16, 1880	1362	Benjamin F. Viltum	Dover	Strafford	Nov. 26, 1880	15

NEW JERSEY.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
1413	May —, 1880	1848	George Kuhl	Egg Harbor C'y	Atlantic	Nov. 3, 1880	19
1414	Apr. 2, 1880	1626	Herman Biggs	Hammonton	...do	Nov. 3, 1880	......
1415	....	......	D. S. Blackman	Port Republic	...do	Dec. 17, 1880	10
1416	Jan. 19, 1880	1100	John H. Brakely	Bordentown	Burlington	Nov. 17, 1880	20
1417	Oct. 22, 1879	937	Pierre Lorillard	Jobstown	...do	Nov. 13, 1879	30
1418	Oct. 22, 1879	937	...do	...do	...do	Jan. 10, 1881	33
1419	Dec. 10, 1880	3215	J. C. Hinchman	Medford	...do	Dec. 10, 1880	20
1420	Aug. 26, 1880	2235	John S. Collins	Moorestown	...do	Nov. 11, 1880	21
1421	Mar. 20, 1880	1543	Amos Ebert	Kirkwood	Camden	Oct. 13, 1880	15
1422	Jan. 20, 1880	1144	D. W. Allen	Vineland	Cumberland	Nov. 3, 1880	......
1423	Apr. 6, 1880	1620	William S. Morris	Mont Clair	Essex	Nov. 29, 1880	20
1424	Jan. 15, 1880	1088	Alexander Barclay	Newark	...do	Nov. 9, 1880	20
1425	Jan. 8, 1880	1083	W. H. Goldsmith	...do	...do	Nov. 10, 1880	20
1426	Jan. 10, 1880	1038	Hiram Cook	Verona	...do	Nov. 10, 1880	20
1427	Apr. 17, 1880	1761	Isaac Leonard	Franklinville	Gloucester	Nov. 9, 1880	15
1428	Dec. 30, 1879	1044	Hon. W. H. House	Wenonah	...do	Nov. 3, 1880	......
1429	Aug. 22, 1879	902	Milton P. Peirce	...do	...do	—— —, 1879	30
1430	Nov. 15, 1880	3005	E. L. Hall	Woodbury	...do	Nov. 15, 1880	20
1431	Feb. 6, 1880	1227	S. H. Kirby	...do	...do	Nov. 20, 1880	15
1432	Nov. 10, 1880	2731	W. A. Holmes	Bayonne	Hudson	Nov. 10, 1880	15
1433	Jan. 13, 1880	1146	J. T. Conover	Pattenburg	Hunterdon	Nov. 4, 1880	......
1434	Jan. 10, 1880	1086	C. B. Applegate	Hightstown	Mercer	Dec. 8, 1880	20
1435	Feb. 6, 1880	1295	Stephen D. Ely	...do	...do	Nov. 4, 1880	......
1436	Nov. 25, 1879	1000	E. J. Anderson	Trenton	...do	Nov. 4, 1880	......
1437	Jan. 28, 1880	1042	Lyttleton White	Eatontown	Monmouth	Nov. 15, 1880	20
1438	May 19, 1880	1966	Newell S. Carhart	Key Port	...do	Nov. 10, 1880	20
1439	May 13, 1881	4605	B. M. Hartshorne	Highlands	...do	May 18, 1881	15
1440	Apr. 22, 1880	1841	Robert Kirby	Imlaystown	...do	Nov. 12, 1880	20
1441	Dec. 9, 1880	3275	Willis Scott	Perrineville	...do	Dec. 9, 1880	15
1442	Nov. 22, 1880	2869	W. S. Backlire	Red Bank	...do	Nov. 22, 1880	20
1443	Dec. 13, 1880	1181	John H. Patterson	...do	...do	Nov. 27, 1880	40
1444	Dec. 9, 1880	3271	Abram Cooper	Chester	Morris	Dec. 9, 1880	15
1445	Dec. 9, 1880	3268	E. M. Kellinger	...do	...do	Dec. 9, 1880	15
1446	Dec. 9, 1880	3270	William Willard	...do	...do	Dec. 9, 1880	15
1447	Dec. 9, 1880	3270	...do	...do	...do	Jan. 12, 1881	20
1448	Dec. 9, 1880	3269	James C. Yawger	...do	...do	Dec. 9, 1880	15
1449	Apr. 3, 1880	1663	M. M. Osborn	Madison	...do	Nov. 10, 1880	20
1450	Dec. 9, 1880	3277	H. A. Bray	Morristown	...do	Dec. 9, 1880	15
1451	Dec. 9, 1880	3277	...do	...do	...do	Jan. 10, 1881	20
1452	Dec. 3, 1880	3184	F. G. Burnham	...do	...do	Dec. 3, 1880	20
1453	Dec. 4, 1880	3198	Theron Butterworth	...do	...do	Dec. 4, 1880	20
1454	Dec. 4, 1880	3192	D. B. Cobb	...do	...do	Dec. 4, 1880	20
1455	Dec. 4, 1880	3191	Mrs. George F. Cobb	...do	...do	Dec. 4, 1880	......
1456	Dec. 1, 1880	3262	August Cutler	...do	...do	Dec. 1, 1880	20
1457	Dec. 1, 1880	3262	...do	...do	...do	Feb. 5, 1881	20
1458	Feb. 12, 1880	626	Hon. A. W. Cutler	...do	...do	Nov. 20, 1880	20
1459	Feb. 12, 1880	626	...do	...do	...do	Dec. 14, 1880	20
1460	Dec. 4, 1880	3194	C. C. Craig	...do	...do	Dec. 4, 1880	20
1461	Dec. 9, 1880	3278	Mrs. Julia De Mott	...do	...do	Dec. 9, 1880	15
1462	Dec. 9, 1880	3278	...do	...do	...do	Jan. 20, 1881	20
1463	Dec. 4, 1880	3186	J. I. Derry	...do	...do	Dec. 4, 1880	20
1464	Dec. 4, 1880	3197	Thomas B. Flagley	...do	...do	Dec. 4, 1880	......
1465	Dec. 4, 1880	3190	John T. Foote	...do	...do	Dec. 4, 1880	......
1466	Dec. 9, 1880	3276	Stephen A. Greim	...do	...do	Dec. 9, 1880	15
1467	Dec. 9, 1880	3276	...do	...do	...do	Jan. 12, 1881	20

Table showing by States the final destination of carp distributed, &c.—Continued.

NEW JERSEY—Continued.

Serial number.	Application filed.		Name.	Locality.		Delivery of carp.	
	Date.	Number.		Post-office.	County.	Date.	Number.
1468	Dec. 4, 1880	3196	B. C. Guerin	Morristown	Morris	Dec. 4, 1880	20
1469	Dec. 4, 1880	3193	B. F. Howell	...do	...do	Dec. 4, 1880	20
1470	Dec. 4, 1880	3199	Monroe Howell	...do	...do	Dec. 4, 1880	20
1471	Dec. 4, 1880	3189	F. S. Lathrop	...do	...do	Dec. 4, 1880	20
1472	Dec. 1, 1880	3261	John Lidgewood	...do	...do	Dec. 1, 1880	20
1473	Dec. 4, 1880	3201	H. O. Mauh	...do	...do	Dec. 4, 1880	20
1474	Dec. 4, 1880	3195	Charles E. Noble	...do	...do	Dec. 4, 1880	20
1475	Dec. 4, 1880	3200	Edward Pierson	...do	...do	Dec. 4, 1880	20
1476	Dec. 4, 1880	3202	H. C. Pitney	...do	...do	Dec. 4, 1880	20
1477	Apr. 26, 1882	13399	Gov. Theo. F. Randolph.	...do	...do	Dec. 4, 1880	20
1478	Dec. 4, 1880	3187	H. B. Stone	...do	...do	Dec. 4, 1880	20
1479	Dec. 9, 1880	3274	E. B. Woodruff	...do	...do	Dec. 9, 1880	15
1480	Dec. 9, 1880	3274	...do	...do	...do	Jan. 11, 1881	15
1481	Dec. 9, 1880	3266	De Witt Quimby	Parsippany	...do	Dec. 9, 1880	15
1482	Dec. 9, 1880	3266	...do	...do	...do	Jan. 10, 1881	15
1483	Dec. 9, 1880	3279	Richard Smith	...do	...do	Dec. 9, 1880	15
1484	Dec. 9, 1880	3279	...do	...do	...do	Jan. 21, 1881	......
1485	Dec. 9, 1880	3267	Edmund D. Halsey	Rockaway	...do	Dec. 9, 1880	15
1486	Dec. 9, 1880	3267	...do	...do	...do	Dec. 13, 1880	15
1487	Dec. 9, 1880	3267	...do	...do	...do	Feb. 1, 1881	25
1488	Dec. 9, 1880	3265	William Howell	Whippany	...do	Dec. 9, 1880	15
1489	Dec. 9, 1880	3265	...do	...do	...do	Jan. 25, 1881	15
1490	Mar. 3, 1880	1487	G. E. Errington	Whiting	Ocean	Nov. 3, 1880	......
1491	Nov. 10, 1880	2730	Thomas Barbour	Paterson	Passaic	Nov. 10, 1880	20
1492	Dec. 2, 1880	3177	William Barbour	...do	...do	Dec. 2, 1880	20
1493	Dec. 2, 1880	3179	J. S. Rogers	...do	...do	Dec. 2, 1880	20
1494	....	......	P. R. George	Ringwood	...do	Jan. 10, 1881	50
1495	Mar. 10, 1880	1599	Wins'w Schoonmaker	Singac	...do	Nov. 15, 1880	20
1496	Dec. 9, 1880	3272	George I. Seney	Bernardsville	Somerset	Dec. 9, 1880	15
1497	Dec. 9, 1880	3273	A. V. Stout	...do	...do	Dec. 9, 1880	15
1498	Jan. 31, 1880	1025	B. M. Field	Boundbrook	...do	Nov. 11, 1880	20
1499	Feb. 21, 1880	1351	Theodore F. Young	Andover	Sussex	Nov. 4, 1880	......
1500	....	......	Charles B. Majer	Elizabeth	Union	....	......
1501	June 14, 1880	2074	John Dietrich	Plainfield	...do	Nov. 9, 1880	15
1502	Dec. 1, 1880	3171	C. R. Maltby	...do	...do	Dec. 1, 1880	20
1503	Dec. 9, 1880	3263	E. C. Maltby	...do	...do	Dec. 9, 1880	20
1504	Dec. 8, 1880	3208	Percy C. Ohl	...do	...do	Dec. 8, 1880	20
1505	Dec. 9, 1880	3264	E. G. Smith	...do	...do	Dec. 9, 1880	20
1506	....	......	J. R. Shotwell	Rahway	...do	Nov. 26, 1880	20

NEW YORK.

Serial number.	Date.	Number.	Name.	Post-office.	County.	Date.	Number.
1507	Mar. 24, 1880	1357	P. L. Eastman	Albany	Albany	May 8, 1880	10
1508	Jan. 1, 1880	1091	W. C. Little	...do	...do	Dec. —, 1880	20
1509	Mar. 6, 1880	1500	Chauncy Miller	Shakers	...do	May 10, 1880	10
1510	....	......	George I. Seney	Bernhardt's Bay.*	Oswego	Dec. 15, 1880	15
1511	June 21, 1880	2090	J. F. Johnson	Olean	Cattaraugus	Dec. 21, 1880	20
1512	Aug. 12, 1880	2206	J. E. Carpenter	Lowman	Chemung	Oct. 29, 1880	......
1513	Nov. —, 1880	2898	Henry Tew	New Berlin	Chenango	Nov. 25, 1880	20
1514	Mar. 22, 1880	1779	Nathaniel Finch	North Pitcher.	...do	Nov. 18, 1880	20
1515	June 16, 1880	2083	I. M. Guernsey	Norwich	...do	Nov. 19, 1881	20
1516	July 15, 1880	2174	Edmund G. Dow	Sherburne	...do	Oct. 29, 1880	......
1517	Apr. 24, 1880	1759	Norman Stall	Elizaville	Columbia	Nov. 30, 1880	10
1518	Apr. 5, 1880	1651	Daniel Bidwell	Mellenville	...do	Jan. 10, 1881	13
1519	Feb. 12, 1880	1341	Peter B. Powers	Amenia	Dutchess	May 15, 1880	10
1520	Dec. 1, 1879	2577	P. A. M. Van Wyck	New Hamburg	...do	Dec. 1, 1879	20
1521	Jan. 14, 1880	1122	William McMillan	Buffalo	Erie	Jan. 12, 1881	13
1522	Oct. 4, 1880	2387	John E. Wells	Johnstown	Fulton	Dec. 25, 1880	20
1523	Mar. 30, 1880	1339	D. R. Prindle	East Bethany.	Genesee	Nov. 13, 1880	14
1524	Mar. 30, 1880	1339	...do	...do	...do	May 22, 1880	10
1525	Apr. 9, 1880	1727	Hiram A. Gates	Coxsackie	Greene	May 30, 1880	12
1526	Feb. 20, 1880	1265	Dexter Van Ostrand.	Watertown	Jefferson	May 26, 1880	......
1527	Nov. 4, 1880	2710	David Acker	Brooklyn, E.D.	Kings	Nov. 4, 1880	20
1528	Nov. 21, 1879	2533	Arthur W. Benson	...do	...do	Nov. 9, 1880	20
1529	June 29, 1880	3041	Hon. S. B. Chittenden	...do	...do	June 29, 1880	10
1530	Dec. 14, 1880	3219	A. B. Crossman	East N. York	...do	Dec. 14, 1880	20
1531	....	......	John Y. Cuyler	Brooklyn	...do	Dec. 2, 1879	25
1532	Nov. 24, 1880	2888	...do	...do	...do	Nov. 24, 1880	50
1533	Dec. 10, 1879	2597	H. D. McGovern	...do	...do	Dec. 10, 1879	25
1534	Dec. 10, 1879	2597	...do	...do	...do	Feb. 15, 1881	40

* Perhaps error for Bernardsville, N. J. See Number 1496.

Table showing by States the final destination of carp distributed, &c.—Continued.

NEW YORK—Continued.

Serial number.	Application filed.		Name.	Locality.		Delivery of carp.	
	Date.	Number.		Post-office.	County.	Date.	Number.
1535	Dec. 2, 1879	2580	Prospect Park	Brooklyn	Kings	Dec. 2, 1879	20
1536	Dec. 2, 1879	2580	do	do	do	Nov. 24, 1880	50
1537	Nov. 26, 1880	2894	Horace E. Stillman	do	do	Nov. 26, 1880	20
1538			Hon. E. Merill	Lowville	Lewis	Apr. 22, 1881	12
1539	Nov. 29, 1879	2574	James Annin, jr	Caledonia	Livingston	Nov. 29, 1879	25
1540			New York State hatchery.	do	do	Dec. —, 1879	25
1541	Mar. 12, ——	1523	Edward Cole	Conesus C'ntre	do	May 23, 1880	11
1542	Mar. 20, 1880	1535	M. O. Barker	Nunda	do	May 19, 1880	12
1543	Feb. 20, 1880	1313	Dr. M. B. Jarvis	Canastota	Madison	Jan. 11, 1881	11
1544	June 28, 1880	2130	J. B. Miller	do	do	Oct. 29, 1880	......
1545	Mar. 18, 1880	1592	Daniel Read	Hamilton	do	May 21, 1880	11
1546	Jan. 3, 1880	2639	Seth Green	Rochester	Monroe	Jan. 3, 1880	25
1547	Jan. 3, 1880	2639	do	do	do	May 8, 1880	*330
1548	Dec. 2, 1880	3180	George Adams	New York		Dec. 2, 1880	20
1549	Nov. 14, 1879	969	S. L. M. Barlow	do	New York	Nov. 7, 1880	10
1550	Nov. 15, 1879	973	E. G. Blackford	do	do	—— —, 1879	*500
1551	Nov. 17, 1880	2802	Harris Bogert	do	do	Nov. 17, 1880	20
1552	Nov. 11, 1880	2740	Dr. William Bowlby	do	do	Nov. 11, 1880	20
1553	Dec. 2, 1880	3176	Henry Clair	do	do	Dec. 2, 1880	20
1554	Nov. 22, 1880	2870	W. N. Clark	do	do	Nov. 22, 1880	20
1555	Dec. 1, 1879	2578	W. A. Conklin	do	do	Dec. 1, 1879	15
1556	Dec. 2, 1880	3175	E. O. Goodwin	do	do	Dec. 2, 1880	20
1557	Nov. 12, 1880	2755	E. P. Grout	do	do	Nov. 12, 1880	2
1558	Nov. 15, 1880	2780	F. C. Havemeyer	do	do	Nov. 15, 1880	20
1559	July 19, 1880	2176	W. W. Holcombe	do	do	Nov. 29, 1880	......
1560	Nov. 21, 1879	2532	W. R. T. Jones	do	do	Nov. 21, 1879	6
1561	May 5, 1881	4417	J. E. M. Lordly	do	do	May 9, 1881	20
1562	Nov. 9, 1880	2724	George P. Ludlow†	do	do	Nov. 9, 1880	20
1563	Nov. 22, 1879	990	J. G. Miller	do	do	Nov. 29, 1880	20
1564	Nov. —, 1880	2899	New York Hospital	do	do	Nov. 25, 1880	20
1565	Nov. 6, 1880	2720	L. W. Parker	do	do	Nov. 6, 1880	20
1566	Nov. 6, 1880	2720	do	do	do	Dec. 3, 1880	10
1567	Nov. 26, 1880	2893	E. B. Rogers	do	do	Nov. 26, 1880	20
1568	May 8, 1880	3038	J. Rumal	do	do	May 8, 1880	10
1569	Dec. —, 1880	5215	J. Ruppert	do	do	Dec. —, 1880	20
1570	Dec. 14, 1880	3218	William Sait	do	do	Dec. 14, 1880	20
1571	Nov. 1, 1880	2698	William H. Sanford	do	do	Nov. 1, 1880	5
1572	Nov. 1, 1880	2698	do	do	do	Jan. 12, 1881	5
1573	Nov. 22, 1880	2868	W. H. Schieffelin	do	do	Nov. 22, 1880	20
1574	Nov. 22, 1880	2868	do	do	do	Dec. —, 1880	20
1875	Nov. 3, 1880	2706	E. B. Sutton	do	do	Nov. 3, 1880	‡20
1576	Nov. 3, 1880	2706	do	do	do	Nov. 20, 1880	‡20
1577	Nov. 3, 1880	2706	do	do	do	Nov. 6, 1880	‡20
1578	Nov. 3, 1880	2706	do	do	do	Dec. 6, 1880	‡20
1579	July 27, 1880	3260	James Van Brunt	do	do	July 27, 1880	10
1580	July 27, 1880	3260	do	do	do	Jan. 10, 1881	10
1581	Nov. 22, 1879	2539	George E. Ward	do	do	Nov. 22, 1879	7
1582	Nov. 22, 1879	2539	do	do	do	Dec. 10, 1880	20
1583	Dec. 1, 1880	2885	Frederick Wesson	do	do	Dec. 6, 1880	30
1584	Mar. —, 1881	4305	do	do	do	Mar. —, 1881	30
1585	May 28, 1880	3040	E. R. Wilbur	do	do	May 28, 1880	10
1586	Feb. 5, 1880	1173	William H. S. Wood	do	do	Apr. —, 1880	12
1587	July 1, 1880	2135	L. W. Bristol	Lockport	Niagara	Oct. 9, 1880	20
1588	Apr. 19, 1880	1731	J. T. Watson §	Clinton	Oneida	Jan. 10, 1881	8
1589	Jan. 11, 1881	3412	do	do	do	Mar. 28, 1881	215
1590			Thomas W. Jones	Maynard	do	Nov. 16, 1880	20
1591	July 19, 1880	2177	Burton G. Foster	Vernon	do	Nov. 7, 1880	20
1592	Feb. 25, 1880	1356	William Watson	Whitestown	do	May 12, 1880	11
1593	Nov. 24, 1880	2889	E. W. Woodward	Manlius	Onondaga	Nov. 24, 1880	20
1594	Nov. 24, 1880	2889	do	do	do	Dec. 7, 1880	10
1595	Feb. 16, 1880	1365	E. L. Van Dusen	Geneva	Ontario	May 18, 1880	12
1596	Apr. 14, 1880	1714	John Melvin	Shortsville	do	May 30, 1880	11
1597	Mar. —, 1881	4304	Hon. Lewis Beach	Cornwall	Orange	Apr. 12, 1881	25
1598			Elias Sindel	Greenwood Lake.	do	Jan. 10, 1881	50
1599	Dec. —, 1880	5236	S. S. Masses	Howell's D'pot	do	Dec. —, 1880	20
1600	Dec. —, 1880	5218	W. T. Shaw	Middletown	do	Dec. —, 1880	20
1601	May 29, 1880	2014	John C. Donaldson	Gilbertsville	Otsego	Nov. 9, 1880	20
1602	Nov. 22, 1879	2540	James Harris	Pine Bush	Orange	Nov. 22, 1879	25
1603	Apr. 5, 1880	1698	J. T. Welton	Schenevus	Otsego	June 1, 1880	11
1604	Apr. 5, 1880	2113	Niram Vaughn	Worcester	do	Nov. 26, 1880	20
1605	Nov. 16, 1880	2783	Edward F. Weeks	Glen Cove	Queens	Nov. 16, 1880	20
1606	Nov. 28, 1879	2569	Peter C. Barnum	Hempstead	do	Nov. 25, 1879	15

* For distribution.
† Superintendent New York Hospital.
‡ Returns from Babylon, Suffolk County.
§ Secretary Kirkland Fish Society.

Table showing by States the final destination of carp distributed, &c.—Continued.

NEW YORK—Continued.

Serial number.	Application filed.		Name.	Locality.		Delivery of carp.	
	Date.	Number.		Post-office.	County.	Date.	Number.
1607	Nov. 3, 1880	2707	William H. Bryant	Hempstead	Queens	Nov. 3, 1880	20
1608	Dec. —, 1880	5213	John S. Darnell	Jamaica	do	Dec. —, 1880	20
1609	Dec. —, 1880	5212	R. Van Allen	do	do	Dec. —, 1880	20
1610	Mar. 26, 1880	1529	Charles T. Mitchell	Manhasset	do	May 10, 1880	10
1611	Nov. 21, 1879	2534	Thomas Clapham	Roslyn	do	Nov. 21, 1879	50
1612	Nov. 21, 1879	2534	do	do	do	Feb. 18, 1881	20
1613	Dec. 15, 1880	3221	L. M. S. Moulton	do	do	Dec. 15, 1880	20
1614	Feb. 7, 1880	1229	T. S. Valentine	do	do	Nov. 7, 1881	10
1615	Nov. 12, 1880	2759	O. D. Burtis	Syosset	do	Nov. 12, 1880	20
1616	Nov. 10, 1880	2729	George L. Smith	Whitestone	do	Nov. 10, 1880	20
1617	Dec. —, 1880	5238	E. Browne	Woodside	do	Dec. —, 1880	20
1618	July 30, 1880	2191	Charles F. Erhard	do	do	Nov. 4, 1880	20
1619	Dec. —, 1880	5237	R. E. Steel	do	do	Dec. —, 1880	20
1620	May 4, 1880	1772	Walter A. Wood	Hoosick Falls	Rensselaer	May 14, 1880	10
1621	Dec. —, 1880	5210	W. Flake	Stapleton	Richmond	Dec. —, 1880	20
1622	July 1, 1881	5964	Frank Endicott	Richmond	do	Dec. —, 1880	20
1623	Nov. 11, 1880	2744	Frederick Weissnor	do	do	Nov. 11, 1880	20
1624	Nov. 2, 1880	2428	do	do	do	Nov. 9, 1880	20
1625	Dec. —, 1880	5211	Charles Vrunath	Rossville	do	Dec. —, 1880	20
1626	Nov. 13, 1880	2771	Frederick White	West New Brighton.	do	Nov. 30, 1880	20
1627	Nov. 29, 1880	2895	John F. Hamptman	Pomona	Rockland	Nov. 29, 1880	20
1628	Nov. 27, 1879	2562	C. T. Pierson	Ramapo	do	Nov. 27, 1879	12
1629	Nov. 11, 1880	2739	N. S. Rutter	Sparkill	do	Nov. 11, 1880	20
1630	Mar. 3, 1880	1483	H. D. Grindle, M. D.	Spring Valley	do	Nov. 25, 1880	20
1631	Nov. 5, 1880	2713	Joseph W. Fowler	Thiells	do	Nov. 5, 1880	20
1632	Nov. 5, 1880	2713	do	do	do	Dec. 4, 1880	20
1633	Apr. 4, 1880	1647	A. W. Cutler	Morristown*		Nov. 23, 1880	20
1634	Dec. —, 1880	5217	P. Rust	Franklinton	Schoharie	Dec. —, 1880	20
1635	Apr. 19, 1880	1728	T. V. Smith	Sharon Spring	do	May 19, 1880	10
1636	Nov. 18, 1880	2806	J. Otis Fellows	Hornellsville	Steuben	Nov. 11, 1880	20
1637	Apr. 2, 1880	1646	John E. R. Patten	do	do	July 2, 1880	10
1638	Jan. 29, 1880	1263	C. D. Northrop	Woodhull	do	Aug. 6, 1880	10
1639	Dec. 3, 1880	3182	Alexander McCue	Babylon	Suffolk	Dec. 3, 1880	20
1640	Dec. 1, 1879	2579	F. C. Lawrence	Bay Shore	do	Dec. 1, 1879	25
1641	Feb. 1, 1880	1398	H. Wills	Central Islip	do	May 8, 1880	10
1642	June 12, 1880	2071	S. Harmon Tuthill	East Marion	do	Oct. 29, 1880	.....
1643	May 31, ——	2027	Charles O. Reeves	Greenport	do	Oct. 29, 1880	....
1644	Mar. 26, 1880	1526	Henry Wills	Hauppauge	do	May 8, 1880	10
1645	Dec. —, 1880	5239	Stehlin & Co	Huntington	do	Dec. —, 1880	20
1646	June 3, 1880	2041	George M. Betts	Mattituck	do	Nov. 6, 1880	15
1647	June 1, 1880	2034	George L. Conklin	do	do	Nov. 4, 1880	15
1648	Nov. 15, 1880	2782	I. W. Gildersleeve	do	do	Nov. 15, 1880	20
1649	Nov. 15, 1880	2781	Thomas S. Hallock	do	do	Nov. 15, 1880	20
1650	Apr. 13, 1880	1732	John C. Wells	do	do	May 8, 1880	10
1651	Apr. 17, 1880	1745½	George W. Hopkins	Miller's Place	do	May 11, 1880	5
1652	Apr. 17, 1880	1745	Samuel J. Hopkins	do	do	May 1, 1880	5
1653	Apr. 3, 1880	1691	Lillie J. Young	Riverhead	do	May 8, 1880	10
1654	Mar. 15, 1881	3825	S. L. Gardiner	Sag Harbor	do	Apr. 12, 1881	21
1655	Nov. 6, 1880	2718	Edward Thompson	Saint Johnland	do	Nov. 6, 1880	25
1656	Jan. 15, 1880	1125	N. C. Jessup	West Hampton	do	May 7, 1881	10
1657	May 1, 1880	1892	David P. Ayers	Lebanon Lake	Sullivan	Nov. 10, 1880	20
1658	Aug. 23, 1880	2214	John D. Ruff	Narrowsburgh	do	Oct. 29, 1880	.....
1659	May 22, 1880	2675	William E. Stebbins	Ithaca	Tompkins	May 22, 1880	11
1660	May 10, 1881	4502	J. B. Hawxhurst	Homowack	Ulster	May 16, 1881	20
1661	Jan. 23, 1880	1145	A. L. Pease	Buskirk's Bridge.	Washington	May 12, 1880	10
1662	Mar. 5, 1880	1158	W. McKee	Cambridge	do	May 28, 1880	10
1663	Feb. 20, 1880	1310	Rev. J. H. Houghton	Salem	do	May 25, 1880	10
1664	Apr. 1, 1880	1616	William E. Sill	Sodus Point	Wayne	May 19, 1880	10
1665	Nov. 25, 1879	2554	George W. Dibble	Irvington	Westchester	Nov. 25, 1879	12
1666	Apr. —, 1881	4283	Samuel Whitney	Katonah	do	Apr. —, 1881	.....
1667	May 12, 1880	3039	Daniel Oakley	Mount Vernon	do	May 12, 1880	10
1668	Dec. 20, 1880	3227	Ed. Waldron	Gage	Yates	Dec. 20, 1880	20
1669	Nov. 1, 1880	2699	S. K. Satterlee	Rye	Westchester	Nov. 14, 1881	20
1670	Nov. 18, 1880	2807	Peter S. Hoe	Tarrytown	do	Nov. 18, 1880	20

* Essex County, N. J.

Table showing by States the final destination of carp distributed, &c.—Continued.

NORTH CAROLINA.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
1671	....	....	P. W. Stoneback	Lilesville	Anson	Dec. 13, 1880	40
1672	Dec. 22, 1879	1022	S. G. Worth	Morgantown	Burke	Jan. 7, 1880	200
1673	Dec. 22, 1879	1022	....do	....do	...do	—— —, 1879	525
1674	Mar. 4, 1880	1466	C. McDonald	Concord	Cabarrus	Nov. 19, 1880	20
1675	....	....	Thomas L. Martin	Harrisburg	....do	Feb. 23, 1881	20
1676	Apr. 12, 1880	1688	Jay B. Harris	Springsville	...do	Nov. 9, 1880	20
1677	Apr. 12, 1880	1636	R. L. Beall	Lenoir	Caldwell	Nov. 9, 1880	......
1678	June 22, 1880	2093	George N. Folk	....do	....do	Dec. 9, 1880	20
1679	Apr. 20, 1880	1760	J. A. Long	Yanceyville	Caswell	Dec. 12, 1880	20
1680	June 25, 1878	370	J. H. Powell	Catawba	Catawba	Nov. 9, 1880	......
1681	Jan. 4, 1882	8147	E. O. Elliott	Sparkling Catawba Sp'gs.	....do	—— —, 1880	......
1682	Mar. 30, 1880	1757	W. H. G. Adney	Pittsborough	Chatham	Nov. 9, 1880	......
1683	....	....	H. B. Short	Flemington	Columbus	Dec. —, 1880	20
1684	Sept. 13, 1880	2354	W. J. Green	Fayetteville	Cumberland	Nov. 9, 1880	24
1685	May 15, 1880	1950	Ira A. Fitzgerald	Linwood	Davidson	Nov. 9, 1880	18
1686	Jan. 10, 1880	1037	J. N. Charles	Jerusalem	Davie	Nov. 9, 1880	......
1687	May 20, 1880	1981	Robert H. Ricks	Rocky Mount	Edgecombe	Nov. 9, 1880	20
1688	Jan. 27, 1880	1197	T. T. Best	Winston	Forsyth	Nov. 9, 1880	20
1689	Apr. —, 1881	4201	L. A. Thornburg	Dallas	Gaston	Apr. 26, 1881	20
1690	May 6, 1880	1904	A. L. Darden	Contentnea	Green	Nov. 9, 1880	20
1691	Mar. 9, 1880	1442	John P. Leach	Littleton	Halifax	Nov. 9, 1880	......
1692	Mar. 15, 1880	1550	Robert McLauchlan	Flat Rock	Henderson	Nov. 9, 1880	......
1693	....	....	H. G. Ewart	Hendersonv'le	do	Dec. 26, 1880	30
1694	June 4, 1880	2046	P. C. Carlton	Statesville	Iredell	Nov. 9, 1880	30
1695	Jan. 7, 1880	1029	W. A. Eliason	....do	....do	Nov. 9, 1880	......
1696	Dec. —, 1880	5190	H. Holder	Harper's	Johnston	Dec. —, 1880	18
1697	Dec. —, 1880	5189	B. C. Cobb	Lincolnton	Lincoln	Dec. —, 1880	18
1698	Mar. 22, 1880	1569	V. A. McBee	....do	....do	Dec. 2, 1880	20
1699	Feb. 4, 1880	1234	C. W. Alexander	Charlotte	Mecklenburgh	Dec. 3, 1880	20
1700	Dec. —, 1880	5193	Walter Brier	....do	....do	Dec. —, 1880	18
1701	Dec. —, 1880	5195	Frank Coxe	....do	....do	Dec. —, 1880	18
1702	Sept. 10, 1879	919	John R. Erwin	....do	....do	Nov. 9, 1880	......
1703	Feb. 17, 1880	1304	W. W. Green	....do	....do	Nov. 9, 1880	......
1704	Dec. 18, 1880	5191	W. W. Grier	...do	....do	Dec. —, 1880	20
1705	Jan. 29, 1880	1221	S. M. Howell	...do	....do	Dec. 3, 1880	20
1706	Sept. 29, 1879	912	Dr. C. N. Hutchinson	...do	....do	Nov. 9, 1880	......
1707	Feb. 17, 1880	1330	Joseph McLaughlin	....do	....do	—— —, 1880	20
1708	Jan. 20, 1880	1139	D. G. Maxwell	....do	....do	Nov. 9, 1880	......
1709	Dec. 18, 1880	5192	W. T. Wilkinson	do	....do	Dec. —, 1880	18
1710	Jan. 29, 1880	1228	W. S. Tomlinson	Bush Hill	Randolph	Nov. 9, 1880	....
1711	May 13, 1880	1868	David Farlow	Level Plains	....do	Nov. 9, 1880	20
1712	May 24, 1880	2002	Joseph Marsh	Leaksville	Rockingham	Nov. 9, 1880	......
1713	....	....	Samuel H. Hand	Reidsville	....do	Mar. 7, 1881	20
1714	Feb. —, 1881	3589	N. Ware	do	....do	Feb. 23, 1881	20
1715	Mar. 12, 1880	1444	R. S. Bethel	Ruffin	....do	Nov. 9, 1880	......
1716	Apr. 29, 1880	1773	T. L. Rawley	....do	....do	Nov. 9, 1880	......
1717	Dec. 3, 1880	2466	W. L. Kistler	Bear Poplar	Rowan	—— —, 1880	......
1718	May 5, 1880	1835	David Barringer	Salisbury	....do	Nov. —, 1880	......
1719	July 5, 1880	2149	A. B. Long	Brittain	Rutherford	Nov. 9, 1880	......
1720	July 5, 1880	2150	W. S. Guthrie	Rutherfordton	...do	Nov. 9, 1880	......
1721	Dec. 7, 1880	3068	E. McArthur	...do	....do	Dec. 17, 1880	......
1722	July 27, 1880	2229	James B. Morris	...do	....do	Nov. 9, 1880	......
1723	Mar. 3, 1879	705	D. N. Dalton	Dalton	Stokes	Nov. 9, 1880	......
1724	Mar. 6, 1880	1474	M. R. Banner	Walnut Cove	....do	Nov. 9, 1880	20
1725	Mar. —, 1880	1490	Abram G. Jones	....do	....do	Nov. 9, 1880	20
1726	Feb. 10, 1880	1321	W. A. Lash	....do	....do	Nov. 9, 1880	20
1727	May 1, 1880	1865	Thomas M. Brower	Mount Airy	Surry	Nov. 9, 1880	......
1728	Apr. 23, 1880	1758	Dr. Thomas H. Avera	Eagle Rock	Wake	Nov. 9, 1880	......
1729	Jan. 17, 1878	172	W. C. Kerr	Raleigh	....do	Nov. 9, 1880	......
1730	Apr. 12, 1880	1733	W. K. Hunter	Rolesville	...do	May 5, 1881	20
1731	....	....	C. A. Barringer	Springfield	Wilkes	Feb. 25, 1881	20
1732	Sept. 29, 1879	913	Col. L. L. Polk	Raleigh	Wake	Nov. 9, 1880	......

OHIO.

1733	June 14, 1880	2076	G. D. Lathrop	Armstrong	Allen	Nov. 17, 1880	16
1734	Apr. 5, 1880	1713	J. A. Myers	McKay	Ashland	Oct. 30, 1880	20
1735	May 24, 1880	2004	Dr. Geo. Weedman	Nova	....do	Nov. 1, 1880	15
1736	Mar. 5, 1880	1479	J. V. Brown	Conneaut	Ashtabula	Nov. 9, 1880	15
1737	Apr. 29, 1881	4084	Dan. A. Grosvenor	Athens	Athens	Apr. 30, 1881	20
1738	Apr. 27, 1881	4085	R. E. Hamblin	....do	....do	Apr. 30, 1881	20
1739	....	....	C. M. McLean	....do	....do	Apr. 30, 1881	30

Table showing by States the final destination of carp distributed, &c.—Continued.

OHIO—Continued.

Serial number.	Application filed.		Name.	Locality.		Delivery of carp.	
	Date.	Number.		Post-office.	County.	Date.	Number.
1740	May —, 1881	4399	C. M. McLean	Athens	Athens	Apr. 13, 1881	30
1741	May 7, 1881	4499	R. H. Stewart	....do	....do	May 16, 1881	20
1742			C. Stinach	....do	....do	May 16, 1880	40
1743	June 3, 1880	2045	James F. Wood	Chase	....do	Nov. 16, 1880	......
1744	Mar. 31, 1880	1556	P. G. Evans	Hebbardsville	....do	Apr. —, 1881	......
1745	May 20, 1880	1975	Edwin A. Brown	Lee	....do	Nov. 16, 1880	......
1746	Apr. 19, 1880	1877	Peter Sears	Barnesville	Belmont	Nov. 16, 1880	......
1747	July 19, 1880	2178	Isaac N. Vail	....do	....do	Nov. 16, 1880	......
1748	Mar. 3, 1880	1873	Thomas W. Gordon	Georgetown	Brown	Nov. 16, 1880	......
1749	Jan. 24, 1880	1153	M. M. Murphy	Ripley	....do	Nov. 16, 1880	......
1750	Apr. 6, 1880	1665	Andrew Phillips	Kilgore	Carroll	Nov. 9, 1880	15
1751	Feb. 13, 1880	1388	Albert Stevenson	Urbana	Champaign	Nov. 16, 1880	......
1752	Apr. 24, 1880	1857	B. B. Scarff	New Carlisle	Clark	Nov. 16, 1880	......
1753	Nov. 1, 1880	2425	C. S. Forgy	....do	....do	Nov. 16, 1880	......
1754	Apr. 6, 1880	1624	Kemp Gaines	Springfield	....do	Nov. 29, 1880	20
1755	Dec. 14, 1880	5063	William T. Keller	Miamiville	Clermont	Dec. 15, 1880	25
1756	Mar. 12, 1880	1461	Samuel A. West	Milford	....do	Nov. 16, 1880	......
1757	Feb. 19, 1880	1300	W. G. Fenwick	Moscow	....do	Nov. 16, 1880	......
1758	Oct. 12, 1880	2399	J. W. Ballard	New Burling'n	Clinton	Nov. 16, 1880	......
1759	Dec. 1, 1880	3064	Leo Weltz	Wilmington	....do	Oct. 14, 1880	20
1760	May 30, 1880	1862	S. O. Hawkins	Bucks	Columbiana	Oct. 30, 1880	20
1761	May 30, 1880	1862	....do	....do	....do	Jan. 13, 1881	17
1762	July 1, 1880	2138	Andy Lindsay	Columbiana	....do	Oct. 30, 1880	......
1763	Feb. 28, 1880	1374	John J. Oehrle	Leetonia	....do	Oct. 30, 1880	......
1764	Mar. 10, 1880	1459	Geo. W. Armstrong	New Lisbon	....do	Nov. 11, 1880	15
1765	Apr. 14, 1880	1641	B. F. Miller	....do	....do	Oct. 30, 1880	......
1766	May 1, 1880	1858	Charles Gamble	Salem	....do	Jan. 1, 1881	14
1767	May 31, 1880	2025	Samuel Gamble	....do	....do	Nov. 10, 1880	14
1768	May 1, 1880	1859	Timothy Gee	....do	....do	Jan. 12, 1881	15
1769	May 12, 1880	1939	Rush Taggart	....do	....do	Nov. 11, 1880	......
1770	Jan. 6, 1880	1099	W. F. Fisher	Galion	Crawford	Oct. 30, 1880	......
1771	Jan. 10, 1880	1128	Dr. Theodotus Garlick.	Bedford	Cuyahoga	Nov. 4, 1880	15
1772	May 13, 1880	1943	J. J. Stranaham	Chagrin Falls	....do	Nov. 6, 1880	15
1773	Dec. 29, 1879	1027	Dr. T. Garlick	Cleveland	....do	—— —, 1880	......
1774	Dec. 28, 1881	1985	W. J. Gordon	....do	....do	Nov. 4, 1880	15
1775	Apr. 5, 1880	1682	H. C. Herron	....do	....do	Nov. 4, 1880	15
1776	June 1, 1880	2035	J. W. Kinney	....do	....do	Oct. 30, 1880	......
1777	Apr. 29, 1880	1861	Jacob Loesch	....do	....do	Nov. 2, 1880	15
1778	July 20, 1880	2180	Charles Paine	....do	....do	Nov. 9, 1880	16
1779	June 30, 1880	2226	J. H. Salisbury	....do	....do	Nov. 14, 1880	15
1780	May 10, 1880	1926	J. C. Schenck, M. D.	....do	....do	Nov. 4, 1880	15
1781	Nov. 1, 1880	2701	Dr. E. Sterling	....do	....do	Nov. 1, 1880	1,200
1782	May 11, ——	1931	H. R. Pardee	Strongsville	....do	Nov. 10, 1880	15
1783	Mar. 22, 1880	1532	George H. Smith	....do	....do	Oct. 30, 1880	......
1784	May 20, 1880	1982	William H. Stevens	Constantia	Delaware	Nov. 16, 1880	......
1785	Feb. 13, 1880	1137	Fred'k P. Vergon	Delaware	....do	Nov. 16, 1880	......
1786	Jan. 24, 1880	1092	Gustin Havens	Lewis Centre	....do	Dec. 20, 1880	20
1787	Apr. 24, 1880	1856	Solomon Boger	Norton	....do	Dec. 6, 1880	20
1788	Feb. 25, 1880	1030	C. A. Hedges	Lancaster	Fairfield	Nov. 16, 1880	......
1789	Mar. 5, 1880	1033	W. H. Strode	....do	....do	Jan. 9, 1881	......
1790	Jan. 14, 1880	1034	John A. Jacobs	Lockville	....do	Jan. 11, 1881	......
1791	Mar. 31, 1880	1601	E. J. Blount	Columbus	Franklin	Nov. 16, 1880	......
1792	Feb. 23, 1880	1390	J. L. Stelzig	....do	....do	Dec. 17, 1880	20
1793	May 1, 1880	1893	C. E. Davis	Dublin	....do	Nov. 16, 1880	......
1794	Apr. 23, 1880	1798½	P. G. Thompson	Gallipolis	Gallia	Nov. 16, 1880	......
1795	Apr. 23, 1880	1798	R. P. Thompson	....do	....do	Nov. 16, 1880	......
1796	July 8, 1880	2157	Henry C. Tuttle	Burton	Geauga	Nov. 6, 1880	15
1797	Jan. 19, 1880	1115	M. R. Parsons	Chardon	....do	Oct. 30, 1880	......
1798	Nov. 6, 1880	2717	M. R. Sasson	....do	....do	Nov. 6, 1880	15
1799	Jan. 15, 1880	1204	A. G. Kent	Geauga Lake	....do	Oct. 30, 1880	......
1800	Sept. 21, 1880	2364	John Schantz	Zimmerman	Greene	Nov. 16, 1880	......
1801	Nov. 18, 1880	2815	R. B. Bowlen		Hamilton	Nov. 18, 1880	20
1802	Dec. 15, 1880	5075	Charles Agetz	Cincinnati	....do	Dec. 15, 1880	20
1803	Mar. 5, 1879	691	H. B. Banning	....do	....do	Oct. 31, 1879	39
1804	Oct. 31, 1879	2481	Cincinnati Ice Co.	....do	....do	Oct. 31, 1879	16
1805	Dec. 2, 1878	532	James Colton	....do	....do	—— — 1879	16
1806	Dec. 2, 1878	532	....do	....do	....do	Dec. —, 1880	20
1807	June 20, 1879	812	James Cullen	....do	....do	—— — 1879	16
1808	June 20, 1879	812	....do	....do	....do	Dec. —, 1880	20
1809	Dec. 15, 1880	5073	William P. Devon	....do	....do	Dec. 15, 1880	20
1810			Susan Gest	....do	....do	Dec. 15, 1880	10
1811	Dec. 15, 1880	5072	L. H. Keissling	....do	....do	Dec. 15, 1880	20
1812	Jan. 24, 1880	1152	Herbert Knight	....do	....do	Nov. 16, 1880	..
1813	Dec. 15, 1880	5074	James Morgan	....do	....do	Dec. 15, 1880	20
1814			O. Mullert	....do	....do	Oct. 20, 1880	20

Table showing by States the final destination of carp distributed, &c.—Continued.

OHIO—Continued.

Serial number.	Application filed.		Name.	Locality.		Delivery of carp.	
	Date.	Number.		Post-office.	County.	Date.	Number.
1815	Nov. 18, 1880	2688	Hugo Mulertt	Cincinnati	Hamilton	Dec. —, 1880	500
1816	Jan. 12, 1880	1026	Theodore Sengstak	...do	...do	Dec. 11, 1880	20
1817	Jan. 8, 1879	527	Adolph Strauch	...do	...do	Oct. 31, 1879	17
1818	Nov. 18, 1880	2812	Frank J. Thompson	...do	...do	Nov. 18, 1880	1600
1819	Aug. 20, 1881	5674	Casimir Werk	...do	...do	Dec. 15, 1880	20
1820	Dec. 12, 1880	3072	Cincinnati Workhouse.	...do	...do	Jan. 12, 1881	20
1821	Dec. 14, 1880	5064	Isaac M. Wise	College Hill	...do	Dec. 15, 1880	25
1822	Dec. 14, 1880	5065	Augustus Muth	Mt. Healthy	...do	Dec. 15, 1880	25
1823	Dec. 14, 1880	5066	Henry W. C. Muth	do	...do	Dec. 15, 1880	25
1824			Henry Bachman	Mt. Washington.	...do	Dec. 15 1880	20
1825	Dec. 14, 1880	5069	R. H. Andrews	Wyoming	...do	Dec. 15, 1880	20
1826	Mar. 1, 1880	1493	Charles Senseman	Tippecanoe	Harrison	Dec. 3, 1880	20
1827	May 10, 1880	1917	John B. Brown	Nashville	Holmes	Nov. 18, 1880	15
1828	Feb. 3, 1880	1194	A. R. Leggett	...do	...do	Dec. 24, 1880	......
1829	Mar. 15, 1880	1575	Simon Peter	Chicago	Huron	Nov. 4, 1880	8
1830	Mar. 15, 1880	1575	...do	...do	...do	Nov. 5, 1880	15
1831	Mar. 15, 1880	1575½	Dr. D. H. Young	...do	...do	Nov. 4, 1880	7
1832	Mar. 15, 1880	1575½	...do	...do	...do	Nov. 5, 1880	15
1833	Mar. 1, 1880	1307	C. H. Hoyt	Norwalk	...do	Oct. 30, 1880	......
1834	Sept. 6, 1881	2347	Alfred Bascom	Steuben	...do	Nov. 4, 1880	15
1835	Feb. 9, 1880	1363	T. F. Van Voorhis	Bladensburg	Knox	Oct. 31, 1880	......
1836	May 20, 1880	1984	Frank H. Withington	Kirtland	Lake	Nov. 10, 1880	15
1837	Oct. 21, 1881	6873	J. H. Hart	Mentor	...do	May 9, 1881	20
1838	July 9, 1880	2158	W. M. Cunningham	Newark	Licking	Nov. 16, 1880	......
1839	Sept. 7, 1878	440	E. W. Metcalfe	Elyria	Lorain	Oct. 30, 1880	......
1840	Apr. 5, ——	1632	De Gras Thomas	Rochester Depot.	...do	Oct. 30, 1880	......
1841	May 20, 1880	1978	C. W. Horr	Wellington	...do	Nov. 8, 1880	15
1842	Feb. 7, 1880	1340	E. D. Potter	Toledo	Lucas	Dec. 8, 1880	750
1843	Feb. 18, 1881	3641	Newton N. Reese	Le Roy	Medina	May —, 1881	......
1844	May 24, ——	1998	William F. Boyer	Wadsworth	...do	Oct. 30, 1880	......
1845	Jan. 5, 1880	1101	A. L. Carman	...do	...do	Oct. 30, 1880	......
1846	Sept. 13, 1880	2356	James R. Morrell	Litchfield	...do	Nov. 4, 1880	15
1847	July 3, 1879	823	Charles Le Blond	Celina	Mercer	Nov. 4, 1880	......
1848	Jan. 14, 1880	1121	D. M. Connaughey	Tippecanoe City.	Miami	Nov. 16, 1880	......
1849	Jan. 25, 1881	3439	Samuel Wampler	Dayton	Montgomery	Dec. 14, 1881	30
1850	Aug. 30, 1880	2238	W. E. Logan	Andrews	Morrow	Dec. 4, 1880	20
1851	Mar. 1, 1880	1464	B. V. Moore	Rix's Mills	Muskingum	Nov. 16, 1880	......
1852	Feb. 29, 1880	1393	Wm. Sunderland	Zanesville	...do	Nov. 16, 1880	......
1853	Feb. 14, 1880	1285	Henry Brown	Piketon	Pike	Nov. 16, 1880	......
1854	Mar. 3, 1880	1290	R. P. Cannon	Aurora	Portage	Nov. 4, 1880	15
1855	Apr. 12, 1880	1740	R. M. Risk	Brimfield	...do	Jan. 10, 1881	15
1856	Sept. 20, 1880	5416	William Moore	Camden	Preble	Nov. 16, 1880	......
1857	Nov. 20, 1880	2865	...do	...do	...do	Nov. 20, 1880	20
1858	Dec. 14, 1880	5068	John C. Entrekin	Chillicothe	Ross	Dec. 15, 1880	20
1859	Dec. 14, 1880	5061	Ingham Mills & Co	...do	...do	Dec. 15, 1880	20
1860	June 30, 1879	828	Louis Leppelman	Tremont	Sandusky	Nov. 4, 1879	16
1861	Jan. 25, 1880	1185	John L. Ward	Portsmouth	Scioto	May —, 1881	......
1862	May 8, 1880	1821	Horace Huber	Tiffin	Seneca	Nov. 23, 1880	16
1863	May 29, 1880	2018	D. M. Slusser & Son	Louisville	Stark	Jan. 10, 1881	......
1864	Feb. 12, 1880	1280	Samuel P. Bachtel	McDonaldsville.	...do	Nov. 10, 1880	15
1865	Mar. 8, 1880	1448	James Bayliss, sr	Massillon	...do	Jan. 10, 1881	15
1866	May 22, 1880	1995	Arvine C. Wales	...do	...do	Oct. 30, 1880	......
1867	June 15, 1880	2078	J. F. Buck	Mt. Union	...do	Nov. 4, 1880	15
1868	Apr. 10, 1880	1638	T. W. McCue	North Lawrence.	...do	Oct. 30, 1880	......
1869	Apr. 6, 1880	1679	Horace B. Camp	Cuyahoga Falls	Summit	Nov. 3, 1880	15
1870	Apr. 26, 1880	1775	David Fosdick	...do	...do	Nov. 3, 1880	15
1871	Jan. 12, 1880	1218	Ralph H. Lodge	...do	...do	Nov. 4, 1880	15
1872	Jan. 12, 1880	1218	...do	...do	...do	Jan. —, 1881	......
1873	June 27, 1880	2127	S. P. McFall	Newton Falls	Trumbull	Nov. 6, 1880	15
1874	Nov. 5, 1880	1453	M. B. Carter	Lebanon	Warren	Nov. 25, 1880	20
1875	Apr. 15, 1880	1700	Rufus B. Putnam	Harmar	Washington	Nov. 16, 1880	......
1876	Dec. 14, 1880	5067	John Hall	Marietta	...do	Dec. 15, 1880	10
1877	Apr. 19, 1880	1724	John Lee	Big Prairie	Wayne	Nov. 15, 1880	15
1878	Feb. 19, 1880	1157	Charles Mathews	Fredericksburgh.	...do	Nov. 18, 1880	15
1879	May —, 1881	4639	J. H. Rumbaugh	Deunquat	Wyandot	May —, 1881	24

Table showing by States the final destination of carp distributed, &c.—Continued.

PENNSYLVANIA.

Serial number.	Application filed.		Name.	Locality.		Delivery of carp.	
	Date.	Number.		Post-office.	County.	Date.	Number.
1880	Jan. 20, 1880	1244	C. C. Lobinger	Braddock	Allegheny	Nov. 15, 1880	15
1881	Apr. 12, 1880	1692	R. L. Jones	Hulton	do	Nov. —, 1880	15
1882	Apr. 12, 1880	4242	do	do	do	Nov. 15, 1881	20
1883	Nov. 12, 1880	2454	J. W. Higbee	Library	do	Nov. 15, 1880	20
1884	Dec. 18, 1878	530	George Finley	Pittsburgh	do	—— —, 1879	175
1885	May 31, 1879	819	W. F. Fuadenberg	do	do	—— —, 1879	25
1886	Aug. 22, 1879	851	R. S. Ross	do	do	Oct. 28, 1879	13
1887	May 11, 1881	4401	James Somerville	Brady's Bend.	Armstrong	May 2, 1881	20
1888	Dec. 24, 1881	1503	Charles Stevenson	Frankfort Sp's	Beaver	Nov. —, 1880	15
1889	Apr. 8, 1880	1628	Calvin Goodman	Reading	Berks	May 31, 1880	10
1890	Apr. 7, 1880	1627	David A. Stout	do	do	May 31, 1880	10
1891	Apr. 1, 1880	1660	Christopher Shearer.	Tuckerton	do	Nov. 28, 1880	10
1892	June 29, 1880	2106	Dr. S. C. Baker	Altoona	Blair	Nov. 10, 1880	......
1893	June 29, ——	2109	Jacob Kemp	do	do	Nov. 10, 1880	......
1894	June 29, 1880	2110	D. A. C. Moore	do	do	Nov. 10, 1880	20
1895	May 16, 1880	987	B. L. Hewit	Hollidaysb'rgh	do	June 2, 1880	40
1896	Jan. 12, 1880	1168	J. A. Biddle	Williamsburgh	do	July 22, 1880	16
1897	Feb. 6, 1880	1262	John M. Kellogg	Monroeton	Bradford	Nov. 10, 1880	......
1898	Mar. 10, 1880	1452	George M. Prince	Orwell	do	Nov. 10, 1880	......
1899	Feb. 28, 1880	1322	C. M. Manville	Towanda	do	Nov. 10, 1880	......
1900	......	......	Captain Monneville	do	do	May 2, 1881	25
1901	Oct. 1, 1880	2410	Wilson Malone	Doylestown	Bucks	Nov. 9, 1880	......
1902	June 26, 1880	2101	David H. Taylor	Morrisville	do	Nov. 9, 1880	15
1903	May 1, 1880	1855	H. L. Shutt	New Britain	do	Nov. 3, 1880	......
1904	—— —, 1880	......	A. L. Nickerman	Titusville	Crawford	—— —, 1880	6
1905	......	......	Rees J. Lloyd	Ebensburgh	Cambria	July 3, 1880	9
1906	May 5, 1880	1902	do	do	do	Nov. —, 1880	15
1907	......	......	do	do	do	Dec. —, 1880	20
1908	Sept. 30, 1880	2382	Wm. Thompson, jr	Lemont	Centre	Nov. 16, 1880	16
1909	Feb. 18, 1880	1668	John Wilson	Loveville	do	Nov. 10, 1880	......
1910	......	......	Rush Morton	......	Chester	Nov. 12, 1880	......
1911	May 24, 1880	2000	John F. Glosser	Berwyn	do	Nov. 3, 1880	......
1912	May 15, 1880	1951	James R. Hunt	Glenloch	do	Nov. 3, 1880	......
1913	Apr. 20, 1880	1764	Samuel Fetters	do	do	May 28, 1880	10
1914	Dec. 27, 1881	12538	George D. Hayes	Oxford	do	Dec. 27, 1881	......
1915	Apr. 21, 1880	1763	Samuel Diemer	Spring City	do	May 27, 1880	10
1916	May 10, 1880	1925	C. J. Morton, M. D.	Toughkenamon	do	May 27, 1880	10
1917	......	......	do	do	do	Nov. 10, 1880	20
1918	Apr. 23, 1880	1804	J. Roberts Hoffman	Uwchland	do	May 27, 1880	10
1919	Feb. 20, 1880	1287	Milton Conard	West Grove	do	Jan. 12, 1881	10
1920	......	......	M. Conar	do	do	May 27, 1880	10
1921	Mar. 30, 1880	1564	Joseph Pyle	do	do	May 27, 1880	10
1922	Feb. 2, 1880	1089	W. R. Shelmire	do	do	Nov. 27, 1880	10
1923	Nov. 28, 1879	2570	W. H. Wallace	Clearfield	Clearfield	Nov. 28, 1879	25
1924	......	......	do	do	do	July 2, 1880	36
1925	......	......	George Nelson	Du Bois	do	Apr. 20, 1881	25
1926	June 3, 1880	2043	P. Curley	Williams Gr've	do	Nov. 11, 1880	15
1927	......	......	do	do	do	Jan. 10, 1881	15
1928	Dec. 18, 1880	3081	William Bahme	Numidia	Columbia	Dec. 27, 1880	41
1929	Dec. 23, 1880	3362	do	do	do	Dec. 27, 1880	20
1930	Nov. —, 1880	3002	Hon. J. B. Dick	Meadville	Crawford	Nov. —, 1880	15
1931	Apr. 14, 1881	3976	Samuel B. Dick	do	do	May —, 1881	......
1932	Mar. 24, 1880	1553	C. H. Coburn	Conneautville	do	Nov. 15, 1880	15
1933	June 24, 1877	77	Hon. Simon Cameron	Harrisburg	Dauphin	—— —, 1879	75
1934	May 18, 1880	1964	Mark Willcox	Ivy Mills	Delaware	June —, 1880	8
1935	May 4, 1880	1844	Joseph C. Watson.	Lenni Mills	do	Nov. 3, 1880	......
1936	......	......	do	do	do	Nov. 29, 1881	20
1937	Aug. 24, ——	2215	John P. Crozer	Upland	do	Nov. 3, 1880	......
1938	May 4, 1880	1847	George F. Curwen	Villanova	do	Nov. 16, 1880	19
1939	Dec. 24, 1879	1853	Seth Weeks	Corry	Erie	July 10, 1880	25
1940	......	......	C. Clark Olds	Erie	do	May 18, 1881	15
1941	Mar. 22, 1880	1530	Casper Doll	Fairview	......	Nov. 25, 1880	15
1942	Jan. 26, 1880	1193	E. P. Gibbons	Brownsville	Fayette	May 8, 1881	15
1943	Feb. 15, 1881	3654	J. W. Long	Mount Morris	Green	Nov. 14, 1881	20
1944	......	......	do	do	do	Feb. 9, 1881	10
1945	......	......	do	do	do	Nov. —, 1880	39
1946	May 5, 1880	1846	David Dunn	Huntingdon	Huntingdon	June 2, 1880	7
1947	......	......	do	do	do	Nov. 24, 1880	20
1948	......	2882	E. B. Isett	Spruce Creek	do	Nov. 8, 1881	20
1949	......	......	do	do	do	Dec. 7, 1880	25
1950	Jan. 31, 1881	3804	Johnston Palmer	Black Lick St'n	Indiana	Nov. 11, 1881	20
1951	......	......	do	do	do	May 9, 1881	20
1952	......	......	J. F. Gilmore	Bell's Mill	Jefferson	May 18, 1881	15
1953	Aug. 4, 1880	2199	Jefferson Co. Sportsmen's Association.	Brookville	do	Jan. 11, 1881	15
1954	Feb. 18, 1880	1405	E. A. Atherton	Glenburn	Lackawanna	Nov. 10, 1880	......

Table showing by States the final destination of carp distributed, &c.—Continued.

PENNSYLVANIA—Continued.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
1955	....	......	Herr Bachman	Lancaster	Lancaster	Mar. 28, 1881	20
1956	June 2, 1880	2676	J. P. Creveling	Marietta......	....do	Jan. 12, 1881	1450
1957	Nov. 29, 1880	3009	James Duffy	....do	....do	Nov. 29, 1880	80
1958	Jan. 26, 1880	1180	Benjamin L. Garber	....do	....do	Jan. 11, 1881	10
1959	Apr. 7, 1880	1625	I. K. Weitzel	Enon Valley..	Lawrence.....	Jan. 17, 1881	15
1960	May 24, 1878	305	M. A. Aiken.........	New Castle ...	....do	—— —, 1879	16
1961	....	......	do........	....do	....do	Nov. —, 1880	15
1962	Nov. 22, 1878	547	W. H. Aiken	....do	....do	Nov. 2, 1880	15
1963	Apr. 1, 1880	1677	Andrew Lewis	....do	....do	Nov. 6, 1880	15
1964	Dec. 29, 1881	1201	William A. Walton..	....do	....do	Nov. 2, 1880	......
1965	July 29, 1880	2189½	E. Grove	Fredericksb'h	Lebanon......	Nov. 23, 1880	11
1966	July 28, 1880	2189	J. W. Grove	....do	....do	Nov. 13, 1880	11
1967	Mar. 8, 1880	1499	J. G. Heilman	Jonestown....	....do	June 3, 1881	9
1968	Apr. 27, 1880	1807	Stephen D. Yost.....	Conyngham ..	Luzerne	Jan. 11, 1881	10
1969	....	......	....do..............	....do	....do	June 10, 1880	10
1970	Jan. —, 1880	1189	Charles G. Heylman.	Cogan Station	Lycoming	Nov. 10, 1880	......
1971	Feb. 25, 1882	11328	Andrew Spanogle ..	Lewistown ...	Mifflin	June 1, 1880	10
1972	Feb. 25, 1880	1169	....do..............	....do	....do	June 1, 1880	10
1973	Sept. 20, 1880	2360	J. M. Stoddart.......	Jenkintown ..	Montgomery..	Nov. 22, 1880	20
1974	Nov. 19, 1880	2477	G. W. Poley	Norristown....	....do	Nov. 22, 1880	......
1975	Aug. 3, 1880	2195	M. C. Smylie.........	Bethlehem....	Northampton.	Nov. 3, 1880	......
1976	Jan. 26, 1881	3441	C. C. Straub	Milton.........	Northumberl'd	Feb. 10, 1881	30
1977	Sept. 22, 1880	2366	James Shore	Germantown .	Philadelphia..	Nov. 3, 1880	......
1978	Dec. 8, 1880	3212	Theo. M. Allen	Philadelphia..	....do	Dec. 8, 1880	20
1979	Dec. 8, 1880	3211	Thomas Cochran....	....do	....do	Dec. 8, 1880	20
1980	June 25, 1880	2099	B. F. Fisher	....do	....do	Dec. 4, 1880	15
1981	June 12, 1878	358	George Janney......	....do	....do	Nov. 3, 1880	......
1982	....	......	Prof. W. D. Marsh...	....do	....do	May 9, 1881	20
1983	Dec. 15, 1880	3220	J. H. Michener	....do	....do	Dec. 15, 1880	20
1984	Nov. 29, 1880	3166	C. S. Ridgeway	....do	....do	Nov. 29, 1880	20
1985	July 14, 1880	2170	Henry S. Cochran ...	Shamokin Dam	Snyder	May —, 1881	......
1986	Sept. 10, 1880	2351	Samuel Barclay	Lavansville...	Somerset	Nov. 26, 1880	16
1987	Nov. 27, 1880	3010	Abram Brown........	....do	....do	Nov. 27, 1880	20
1988	Sept. 13, 1880	2355	Jacob F. Walker	....do	....do	Nov. 27, 1880	20
1989	Jan. 30, 1880	1032	J. J. Potter...........	Gibson	Susquehanna .	Nov. 10, 1880	......
1990	Oct. 28, 1880	2423	Geo. M. Doolittle	Susquehanna .	....do	Nov. 20, 1880	20
1991	Oct. 15, 1880	2410	Reuben Close	Chatham Valley	Tioga.........	Nov. 10, 1880	......
1992	Apr. 23, 1880	1801	D. C. Harrower......	Elkland	....do	Nov. 10, 1880	......
1993	Mar. 31, 1880	1540	A. E. Niles	Tioga.........	....do	Nov. 10, 1880	......
1994	Feb. 26, 1880	1406½	C. H. Wickham........	....do	....do	Nov. 10, 1880	......
1995	Feb. 26, 1880	1406	T. A. Wickham........	....do	....do	Nov. 10, 1880	......
1996	Mar. 11, 1880	1394	Loran A. Sears	Wellsborough	....do	Nov. 10, 1880	......
1997	....	......	William Johnson....	Cherry Run...	Union	Jan. 19, 1880	16
1998	Jan. 5, 1880	1087	......do..............	do.........	....do	Nov. 10, 1880	......
1999	Mar. 11, 1880	1590	D. O. Bower	Laurelton.....	....do	Jan. 17, 1881	10
2000	Nov. 19, 1880	3007	John C. Gundy	Lewisburgh ..	....do	Nov. 19, 1880	20
2001	May 4, 1880	2116	C. H. Hassonplug....	....do	....do	Nov. 10, 1880	......
2002	July 6, 1880	2151	P. Speechley	Coal Hill......	Venango......	May —, 1881	15
2003	May 10, 1880	1920	P. R. Gray............	Franklin	....do	Nov. —, 1880	15
2004	Apr. 3, 1880	1871	G. M. Ramsey, M. D .	Clokey........	Washington ..	Nov. —, 1880	15
2005	Feb. —, 1880	1179	......do..............	....do	....do	July 3, 1880	10
2006	May 7, 1880	1912	John S. Knox	East Finley...	....do	—— —, 1880	......
2007	Jan. 14, 1881	3410	......do..............	....do	....do	May —, 1881	15
2008	....	......	A. H. Grow...........	Washington ..	....do	May 2, 1881	20
2009	Apr. 16, 1880	1706	John Hall.............	....do	....do	May —, 1881	15
2010	Mar. 29, 1880	1024	W. L. A. McCracken.	....do	....do	May —, 1881	15
2011	July 3, 1880	2147	J. Shaw Margerum..	....do	....do	Nov. 1, 1880	16
2012	....	......	......do..............	....do	....do	Oct. 17, 1880	20
2013	Oct. 25, 1880	2415	James B. Wilson	....do	....do	Nov. 2, 1880	15
2014	Mar. 16, 1880	1457	D. R. Atkinson	Honesdale	Wayne	Nov. 10, 1880	......
2015	Mar. 16, 1880	1455	Miles L. Tracy	....do	....do	Nov. 10, 1880	......
2016	May 6, 1880	1907	J. F. Lobingier	Laurelville ...	Westmoreland	Jan. 10, 1881	....
2017	....	......	......do..............	....do	....do	Nov. 18, 1880	15
2018	Aug. 29, 1879	848	Duncan McAlister ..	Sardis	....do	Oct. 28, 1879	40
2019	....	......	S. H. Rumbaugh.....	Weaver's Old Stand.	....do	May 3, 1881	25
2020	....	......	T. Benson Gubb	Shrewsbury ..	York	Apr. 25, 1881	20
2021	Apr. 15, 1880	1744	J. Benson Gable.....	Stewartstown.	....do	June 4, 1880	10
2022	....	......	......do..............	do.........	....do	Jan. 10, 1881	7
2023	Dec. 15, 1881	9102	David Strickler ..	York	....do	June 3, 1881	8
2024	June 5, 1880	2048	....do..............	....do	....do	Jan. 11, 1881	16
2025	Dec. 24, 1879	1023	....do ..	....do	....do	Nov. 13, 1880	16
2026	Feb. 23, 1881	3738	John T. Williams, jr.	....do	....do	Nov. 9, 1881	20
2027	....	......	......do..............	....do	....do	Oct. 30, 1880	20
2028	July 15, 1880	2172	John T. Williams ...	....do	....do	Nov. 13, 1880	16

Table showing by States the final destination of carp distributed, &c.—Continued.

RHODE ISLAND.

Serial number.	APPLICATION FILED.		Name.	LOCALITY.		DELIVERY OF CARP.	
	Date.	Number.		Post-office.	County.	Date.	Number.
2029	Oct. 28, 1880	2693	Alex. G. Sanford	Warren	Bristol	Oct. 28, 1880	20
2030	Nov. 5, 1880	2715	Anne C. A. Brown	E. Greenwich	Kent	Nov. 5, 1880	20
2031			John C. Brown	do	do	Oct. 5, 1880	20
2032	Oct. 29, 1880	2694	Dewing & Monsell	Providence	Providence	Oct. 29, 1880	35
2033	Dec. 10, 1880	2704	William Goddard	do	do	Oct. 5, 1880	20
2034	Dec. 6, 1881	2690	James B. Hatchaway	do	do	Oct. 28, 1880	25
2035	Dec. 5, 1881	2728	Frank Hazard	do	do	Nov. 9, 1880	12
2036			Thomas Hazard	do	do	Oct. 5, 1880	12
2037	May 14, 1880	1946	Arnold Jennison	do	do	Nov. 10, 1880	20
2038	Oct. 18, 1880	2686	J. A. Knowles	do	do	Oct. 18, 1880	20
2039	Nov. 5, 1880	2716	F. W. Miner	do	do	Nov. 5, 1880	16
2040			Roger Wm's Parks	do	do	Oct. 5, 1880	25
2041	Oct. 28, 1880	2692	John W. Sawyer	do	do	Oct. 28, 1880	20
2042	Nov. 4, 1880	2711	John H. Barden	Rockland	do	Nov. 4, 1880	22

SOUTH CAROLINA.

2043	Nov. 17, 1877	126	C. O'Donnell	Aiken	Aiken	Nov. —, 1879	16
2044	Nov. 25, 1879	2553	Dr. P. M. Butler	Hamburg	do	Nov. 25, 1879	22
2045	Nov. 20, 1879	2522	W. H. Hammond	do	do	Nov. 20, 1879	20
2046	Nov. 20, 1879	2523	J. M. Hightower	do	do	Nov. 20, 1879	20
2047	Mar. 26, 1879	709	A. M. Holland	Holland's Store	Anderson	Nov. 22, 1880	......
2048	Mar. 21, 1880	1591	I. M. Cave	Elko	Barnwell	Nov. 22, 1880	......
2049	Nov. 27, 1879	2563	F. W. Hayward	Oakley Depot	Charleston	Nov. 27, 1879	42
2050	Oct. 27, 1880	2421	S. B. Massey	Chester C. H.	Chester	Nov. 22, 1880	......
2051	Dec. 10, 1879	2605	S. W. Bookhart, M. D	Blythewood	Fairfield	Dec. 10, 1879	16
2052	Dec. 10, 1879	2605	do	do	do	Jan. 29, 1881	108
2053	Aug. 7, 1880	2201	Chas. H. Ladd, M. D	Buck Head	do	Nov. 22, 1880	......
2054	Nov. 29, 1879	2575	J. L. Black	Ridgeway	do	Nov. 29, 1879	20
2055	Dec. 12, 1879	2616	T. E. Cloud	do	do	Dec. 12, 1879	12
2056	Jan. 17, 1878	177	R. Thurston	Greenville C. H	Greenville	Nov. 22, 1880	......
2057	Apr. 11, 1878	220	Dr. E. M. Boyken	Camden	Kershaw	—— —, 1879	16
2058	Oct. 25, 1881	7100	Z. L. Holmes	Laurens C. H.	Laurens	Dec. 9, 1881	......
2059	Apr. 16, 1880	1701	H. L. Machem	Line Creek	do	Nov. 22, 1880	......
2060	Feb. 10, 1880	1246	Dr. R. Vampill	Mullin's Depot	Marion	Nov. 22, 1880	......
2061	Dec. 4, 1879	2583	Y. W. Glymph	Glymphville	Newberry	Dec. 4, 1879	16
2062	Dec. 15, 1879	2619	James A. Peterken	Fort Motte	Orangeburg	Dec. 15, 1879	16
2063	Dec. 8, 1879	2590	Henry Beard	Columbia	Richland	Dec. 8, 1879	32
2064	June 23, 1880	2095	A. P. Butler	do	do	Nov. 24, 1879	475
2065	June 23, 1880	2095	do	do	do	Nov. 23, 1880	750
2066	Nov. 30, 1879	2576	G. W. Davis	do	do	Nov. 30, 1879	16
2067	Nov. 28, 1879	2571	Levi Gunter	do	do	Nov. 28, 1879	15
2068	Dec. 15, 1878	518	Wade Hampton	do	do	—— —, 1879	1,000
2069	Apr. 26, 1878	241	Nathaniel Ramsay	do	do	Nov. 28, 1879	30
2070	Nov. 27, 1879	2564	W. H. Sligh	do	do	Nov. 27, 1879	35
2071	Nov. 27, 1879	2565	W. H. Stack	do	do	Nov. 27, 1879	25
2072	May 22, 1880	1994	John S. Richardson	Sumter C. H.	Sumter	Nov. 22, 1880	......
2073	May 17, 1878	258	Thomas B. Jeter	Union	Union	Nov. 7, 1879	16
2074	Mar. 20, 1880	1577	John F. Hinson	Guthriesville	York	Nov. 22, 1880	......
2075	Dec. 10, 1879	2606	William B. Tewell	Rock Hill	do	Dec. 10, 1879	12

TENNESSEE.

2076	Jan. 15, 1880	1114	R. H. McCroskey	Cleveland	Bradley	Nov. 16, 1880	......
2077	June 1, 1878	313	E. H. Hawkins	Huntingdon	Carroll	—— —, 1880	......
2078	June 12, 1880	2069	Alexander Campbell	McKenzie	do	Nov. 10, 1880	20
2079	Apr. 9, 1880	1613	John W. Harris	do	do	—— —, 1880	......
2080	Nov. 24, 1880	3148	E. C. Lewis	Sycamore	Cheatham	Nov. 24, 1880	10
2081	Feb. —, 1882	3164	W. F. Gray	Madison	Davidson	Nov. 9, 1880	6
2082	Nov. 24, 1880	2890	G. F. Akers	Nashville	do	Nov. 24, 1880	600
2083	Nov. 5, 1879	966	do	do	do	—— —, 1879	500
2084	Mar. 1, 1880	1170	A. J. Baird	do	do	Nov. 27, 1880	10
2085	Dec. 6, 1880	3205	R. T. Burns	do	do	Dec. 6, 1880	10
2086	Nov. 30, 1880	3167	A. E. Burr	do	do	Nov. 30, 1880	10
2087	Nov. 13, 1879	2497	John H. Callender	do	do	Nov. 13, 1879	300
2088	Nov. 6, 1879	970	do	do	do	Jan. 14, 1881	200
2089	Dec. 1, 1880	3172	Josiah Clawson	do	do	Dec. 1, 1880	4
2090	Nov. —, 1880	3152	George B. Crockett	do	do	Nov. 24, 1880	10
2091	Nov. —, 1880	3141	E. Curtiss	do	do	Nov. —, 1880	10
2092	Nov. 30, 1880	3169	George A. Dickell	do	do	Nov. 30, 1880	6

Table showing by States the final destination of carp distributed, &c.—Continued.

TENNESSEE—Continued.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
2093	Nov. 25, 1880	3153	Duncan R. Dorris	Nashville	Davidson	Nov. 25, 1880	4
2094	Nov. 26, 1880	3160	Mrs. F. Furman	do	do	Nov. 26, 1880	4
2095	Dec. 8, 1879	2591	Frank W. Green	do	do	Dec. 8, 1879	27
2096	Nov. 20, 1879	2524	T. O. Harris	do	do	Nov. 20, 1879	20
2097	Nov. 22, 1879	2542	James A. Harwood	do	do	Nov. 22, 1879	20
2098	Nov. 24, 1880	3143	H. Heiss	do	do	Nov. 24, 1880	26
2099	Nov. 25, 1880	3154	Ira P. Jones	do	do	Nov. 25, 1880	10
2100	Nov. 24, 1880	3147	L. C. Lischy	do	do	Nov. 24, 1880	8
2101	Apr. 9, 1880	1615	George Lumsden	do	do	—— —, 1880	......
2102	Nov. 29, 1880	3165	H. N. McTyeire	do	do	Nov. 29, 1880	10
2103	Nov. 12, 1879	2495	R. C. K. Martin	do	do	Nov. 12, 1879	50
2104	Dec. 7, 1880	3207	Irby Morgan	do	do	Dec. 7, 1880	46
2105	Nov. 26, 1880	3157	K. S. Morris	do	do	Nov. 26, 1880	10
2106	Nov. 24, 1880	3145	W. R. Phillips	do	do	Nov. 24, 1880	8
2107	Dec. 1, 1880	3173	L. A. Robinson	do	do	Dec. 1, 1880	6
2108	......	......	Tennessee Asylum	do	do	—— —, 1880	200
2109	Nov. 24, 1880	3140	M. B. Toney	do	do	Nov. 24, 1880	10
2110	Nov. 24, 1880	3142	Thomas Wain	do	do	Nov. 24, 1880	20
2111	May 29, 1880	2021	James E. Warner	do	do	Nov. 24, 1880	20
2112	Nov. 24, 1880	3146	A. F. Whitman	do	do	Nov. 24, 1880	30
2113	Dec. —, 1880	3214	G. Wilson	do	do	Dec. —, 1880	10
2114	Nov. 24, 1880	3144	Robert Woods	do	do	Nov. 24, 1880	10
2115	Nov. 27, 1880	3163	B. F. Woodward	do	do	Nov. 27, 1880	6
2116	Dec. 6, 1880	3203	J. L. Wrenn	do	do	Dec. 6, 1880	6
2117	......	......	William H. Roberts	do	do	Nov. 23, 1880	10
2118	Nov. 24, 1880	3139	John F. Guntrell	Colesburgh	Dickson	Nov. 24, 1880	10
2119	July 13, 1880	2167	William H. Roberts	Spencer's Mill	do	Nov. 26, 1880	10
2120	Feb. 3, 1880	1273	S. J. Alexander	Macon	Fayette	Jan. 7, 1881	30
2121	Feb. 3, 1880	1273	do	do	do	Jan. 11, 1881	200
2122	Feb. 3, 1880	1306	W. H. Harris	do	do	Jan. 7, 1881	20
2123	Feb. 3, 1880	1332	J. W. Mewborn	do	do	Jan. 17, 1880	100
2124	Feb. 3, 1880	1336	W. B. Porter	do	do	Jan. 7, 1881	20
2125	Dec. 7, 1881	3158	Telfair Hodgson	Sewanee	Franklin	Nov. 26, 1880	8
2126	Nov. 24, 1880	3150	H. H. Rogers	Trenton	Gibson	Nov. 24, 1880	10
2127	Nov. 19, 1880	3134	C. S. Sevies	Greeneville	Greene	Nov. 19, 1880	20
2128	Apr. 13, 1880	1716	A. M. Shook	Tracy City	Grundy	Nov. 16, 1880	......
2129	......	......	J. T. Reed	Chattanooga	Hamilton	Dec. 6, 1880	18
2130	Dec. 22, 1881	8949	C. W. Millet	Grand Junc'n	Hardeman	—— —, 1880	......
2131	Nov. 19, 1880	3136	W. N. Mahaffy	Middleton	do	Nov. 19, 1880	120
2132	Nov. 3, 1880	2438	J. T. Low	Saulsbury	do	Jan. 7, 1881	25
2133	Nov. 3, 1880	2446	H. B. Wright	do	do	Jan. 7, 1881	25
2134	Feb. 21, 1880	1274	J. D. C. Atkins	Paris	Henry	Feb. —, 1880	......
2135	Nov. 26, 1880	2891	T. W. Crawford	do	do	Nov. 26, 1880	25
2136	Nov. 20, 1880	2860	J. M. Hudson	do	do	Nov. 25, 1880	25
2137	Nov. 20, 1880	2861	George McNeill	do	do	Nov. 25, 1880	25
2138	Nov. 20, 1880	2859	James C. McNeill	do	do	Nov. 25, 1880	20
2139	Nov. 20, 1880	2863	J. N. Thomasson	do	do	Nov. 20, 1880	25
2140	Nov. 24, 1880	3149	W. H. Crutcher	Bon-aqua	Hickman	Nov. 24, 1880	10
2141	Nov. 24, 1880	3138	John F. Gamble	do	do	Nov. 24, 1880	20
2142	Dec. 2, 1880	3178	S. M. Wilson	Tenn. Ridge	Houston	Dec. 2, 1880	10
2143	Dec. 6, 1880	3204	J. M. McAdoo	McEwen	Humphrey's	Dec. 6, 1880	6
2144	Dec. 6, 1880	3233	Cullen & Newman	Knoxville	Knox	Dec. 13, 1880	......
2145	Dec. 6, 1880	3233	do	do	do	Jan. 1, 1881	20
2146	Dec. 6, 1880	3233	do	do	do	May —, 1881	......
2147	Nov. 19, 1880	3135	C. C. Zachary	do	do	Nov. 19, 1880	20
2148	July 27, 1879	838	S. M. Clayton	Cyruston	Lincoln	Nov. 24, 1880	10
2149	June 1, 1880	1976	T. J. Dement	Athens	McMinn	Nov. 16, 1880	......
2150	Dec. 3, 1880	3181	P. P. Transou	Denmark	Madison	Dec. 3, 1880	8
2151	Dec. 3, 1880	3181	do	do	do	Jan. 18, 1881	14
2152	Mar. 18, 1877	58	J. Y. Keith	Jackson	do	Nov. 27, 1880	70
2153	......	......	do	do	do	Jan. —, 1881	20
2154	Feb. 12, 1880	694	E. A. Lindsay	do	do	—— —, 1879	20
2155	Oct. 9, 1880	2395	David H. Parker	Medon	do	Jan. 1, 1880	20
2156	......	......	H. F. Parker	do	do	Nov. 26, 1880	25
2157	Oct. 9, 1880	2396	do	do	do	Jan. —, 1881	20
2158	Feb. 6, 1882	9435	Mrs. S. F. Pope	do	do	Feb. 6, 1881	......
2159	Oct. 14, 1880	2400	John T. Read	Shellmound	Marion	Nov. 26, 1880	12
2160	Feb. 12, 1880	1384	E. M. Sheegog	Columbia	Maury	—— —, 1880	......
2161	July 13, 1878	387	T. H. Williams	do	do	Dec. 1, 1880	6
2162	Feb. 12, 1880	1281	W. H. Brown	Spring Hill	do	Nov. 26, 1880	10
2163	Nov. 27, 1880	3162	do	do	do	Nov. 27, 1880	10
2164	Nov. —, 1880	3156	F. A. Thompson	do	do	Nov. —, 1880	10
2165	......	......	J. P. Thompson	do	do	Nov. 27, 1880	12
2166	May 11, 1878	260	E. Y. Salmon	Lynchburg	Moore	Nov. 16, 1880	......
2167	......	......	T. J. Edwards	Union City	Obion	Nov. 30, 1880	10
2168	......	......	G. E. W. Green	Cedar Hill	Robertson	Nov. 27, 1880	10

Table showing by States the final destination of carp distributed, &c.—Continued.

TENNESSEE—Continued.

Serial number.	Application filed.		Name.	Locality.		Delivery of carp.	
	Date.	Number.		Post-office.	County.	Date.	Number.
2169	Nov. 18, 1879	976	F. Pride	Cedar Hill	Robertson	Nov. 27, 1879	10
2170	July 5, 1880	2407	James H. Mallory	Sadlersville	...do	Nov. 27, 1879	10
2171	Dec. 4, 1880	3185	George W. Walker	Springfield	...do	Dec. 4, 1880	6
2172	Apr. 9, 1881	3962	Dr. L. Russell	Murfreesborough.	Rutherford	Apr. 12, 1881	......
2173	Nov. 12, 1880	2763	N. Blackwell	Bartlett	Shelby	Nov. 12, 1880	10
2174	Nov. 12, 1880	2762	E. S. McGowan	...do	...do	Nov. 12, 1880	10
2175	Nov. 13, 1880	3013	Daniel G. Shelby	...do	...do	Nov. 13, 1880	20
2176	Dec. —, 1880	3234	T. H. Magee	Lucy	...do	Dec. —, 1880	20
2177	Feb. 1, 1880	1053	Robert Galloway	Memphis	...do	Nov. 11, 1880	......
2178	Nov. 12, 1880	2761	N. F. Lemaster	...do	...do	Nov. 12, 1880	20
2179	Nov. 15, 1880	3133	O. M. Patterson	...do	...do	Nov. 15, 1880	20
2180	Nov. 12, 1880	2760	William H. Stovall	...do	...do	Nov. 12, 1880	......
2181	Nov. 25, 1880	3151	L. B. Fish	Hendersonville	Sumner	Nov. 25, 1880	10
2182	Dec. 2, 1879	2581	D. F. Mills	...do	...do	Dec. 2, 1879	34
2183	Jan. 3, 1880	3380	R. G. Goodman	Covington	Tipton	Jan. —, 1881	10
2184	Oct. 3, 1881	7315	Thomas W. Roane	...do	...do	—— —, 1881	......
2185	June 19, 1879	813	Geo. F. Hesselmeyer	Haynes	Union	Nov. 16, 1880	......
2186	Nov. 25, 1881	3155	A. C. Beech	McMinnville	Warren	Nov. 25, 1880	10
2187	Jan. 7, 1880	1093	William V. Whitson	...do	...do	—— —, 1880	......
2188	Dec. 6, 1879	1001	Thomas D. Martin	Martin	Weakley	—— —, 1879	......
2189	June 17, 1880	2085	—— Ivy	Basin Spring	Williamson	Nov. 16, 1880	......
2190	Apr. 9, 1880	1718	Isaac Joy	...do	...do	—— —, 1880	......
2191	Nov. 5, 1879	967	J. B. McEwin	Franklin	...do	Nov. 16, 1880	......
2192	Nov. 30, 1880	3168	John McGavock	...do	...do	Nov. 30, 1880	6
2193	Dec. 1, 1880	3170	W. C. McGavock	...do	...do	Dec. 1, 1880	6
2194	June 28, 1880	2129	G. W. Pollard	Rock Hill	...do	—— —, 1880	......
2195	June 28, 1880	2128	Thomas R. Tulloss	...do	...do	Nov. 24, 1880	10
2196	Nov. 26, 1880	3159	P. Peyton Carver	Mt. Juliet	Wilson	Nov. 26, 1880	10

TEXAS.

Serial number.	Application filed.		Name.	Locality.		Delivery of carp.	
	Date.	Number.		Post-office.	County.	Date.	Number.
2197	Dec. 17, 1880	5012	L. M. Hitchcock	Palestine	Anderson	Dec. 17, 1880	20
2198	May 1, 1880	1870	John W. Goode	Bellville	Austin	Dec. 4, 1880	......
2199	June 8, 1880	2055	Grant T. Ross, M. D.	San Felipe	...do	Dec. 4, 1880	......
2200	June 12, 1880	2070	Joseph Keil	Bastrop	Bastrop	Dec. 4, 1880	......
2201	Mar. 16, 1880	1534	James Boyd	Belton	Bell	Jan. 31, 1881	20
2202	June 24, 1880	2096	James Converse	Converse	Bexar	Dec. 4, 1880	......
2203	May 20, 1880	1977	C. C. Gibbs	...do	...do	Dec. 20, 1880	20
2204	Nov. 14, 1879	974	G. W. Breckenridge	San Antonio	...do	Dec. 2, 1879	60
2205	Nov. 14, 1879	974	...do	...do	...do	Dec. 2, 1879	70
2206	May 18, 1880	1963	Ed. Steves	...do	...do	Dec. 4, 1880	......
2207	May 19, 1879	761	Hon. C. Upson	...do	...do	Dec. 4, 1880	......
2208	......	......	R. K. Chatham	Bryan	Brazos	Dec. 15, 1880	20
2209	......	......	J. S. Gawlkes	...do	...do	Dec. 15, 1880	20
2210	Dec. 14, 1880	5052	Charles J. Davis	...do	...do	Dec. 15, 1880	20
2211	Dec. 15, 1880	5049	S. C. Echols	...do	...do	Dec. 15, 1880	20
2212	Dec. 15, 1880	5048	John Humes	College Station	...do	Dec. 15, 1880	20
2213	Apr. 13, 1880	1644	Charles Clark	Hookerville	Burleson	Dec. 4, 1880	......
2214	Dec. 17, 1880	5019	W. F. Blount	Lockhart	Caldwell	Dec. 17, 1880	20
2215	Dec. 17, 1880	5018	L. J. Storey	...do	...do	Dec. 17, 1880	20
2216	June 29, 1880	2131	John L. Felder, M. D.	Leesburg	Camp	Jan. 13, 1881	15
2217	......	......	E. C. Dickinson	Rusk	Cherokee	Feb. 9, 1881	15
2218	May 3, 1881	4384	James P. Gibson	...do	...do	May —, 1881	......
2219	Nov. 27, 1879	2566	R. D. Armond	McKinney	Collin	Nov. 27, 1879	54
2220	Feb. 26, 1878	194	Isaac F. Graves	...do	...do	—— —, 1879	18
2221	Jan. 17, 1878	170	Hon. J. R. Throckmorton.	...do	...do	—— —, 1879	18
2222	Feb. 15, 1879	635	George White	...do	...do	Nov. 27, 1879	18
2223	Sept. 8, 1880	2371	T. J. Finley	Weston	...do	Dec. 4, 1880	......
2224	......	......	E. Potthart	Weimar	Colorado	Dec. 17, 1880	20
2225	May 31, 1880	2023	Frantz Coreth	New Braunfels	Comal	Dec. 4, 1880	......
2226	......	......	Samuel J. Adams	Dallas	Dallas	Nov. 28, 1880	19
2227	Feb. 15, 1879	637	...do	...do	...do	Nov. 23, 1879	80
2228	Feb. 15, 1879	637	...do	...do	...do	Nov. 28, 1879	19
2230	Aug. 30, 1880	2237	Walter Caruth	...do	...do	Dec. 20, 1880	35
2231	Aug. 30, 1880	2236	William Caruth	...do	...do	Dec. 20, 1880	20
2232	Sept. 17, 1880	2359	W. C. Connor	...do	...do	Dec. 12, 1880	380
2233	Feb. 18, 1878	189*	J. W. Kidd	...do	...do	Nov. 28, 1879	16
2235	Nov. 28, 1879	2572	...do	...do	...do	Nov. 28, 1879	16
2236	Dec. 14, 1880	5059	John Thurman	...do	...do	Dec. 15, 1880	20
2237	......	......	J. C. Michener	Hutchins	...do	Dec. 20, 1880	20
2238	Mar. 1, 1880	1824	...do	...do	...do	Dec. 4, 1880	......

* Also Number 552.

Table showing by States the final destination of carp distributed, &c.—Continued.

TEXAS—Continued.

Serial number.	Application filed.		Name.	Locality.		Delivery of carp.	
	Date.	Number.		Post-office.	County.	Date.	Number.
2239	Apr. 6, 1880	1614	D. R. Long	Denton	Denton	Dec. 6, 1880	......
2240	Oct. 23, 1880	2442	John C. Riddle	Pilot Point	....do	Dec. 4, 1880	......
2241	Sept. 25, 1880	2378	T. B. Chalmers	Ennis	Ellis	Dec. 11, 1880	5
2242	Sept. 25, 1880	2377	B. Gatewood	....do	....do	Dec. 11, 1880	5
2243	Nov. 20, 1880	3050	George H. Hogan	....do	....do	Dec. 29, 1880	......
2244	July 9, 1880	2107	J. P. Hotchkiss	....do	....do	Dec. 11, 1880	20
2245	Sept. 25, 1880	2376	M. Latimer	....do	....do	Dec. 11, 1880	5
2246	Sept. 25, 1880	2375	M. H. Oliver	....do	....do	Dec. 11, 1880	5
2247	Dec. 11, 1880	3216	A. H. Rowe	....do	....do	Dec. 11, 1880	20
2248	Nov. 26, 1879	2557	Jer. Q. Sheumith	Bonham	Fannin	Nov. 26, 1879	35
2249	Apr. 2, 1879	722	Francis O'Keefe	Honey Grove	....do	—— —, 1879	20
2250	Feb. 26, 1878	191	Patrick O'Keefe	....do	....do	Nov. 25, 1879	20
2251	Jan. —, 1877	41	Albert Modlen	Orangeville	....do	Oct. 28, 1879	18
2252	Nov. 26, 1879	2559	Alfred Medloe	Richlandville	....do	Nov. 26, 1880	18
2253	Dec. 17, 1880	5025	C. Faellner	High Hill	Fayette	Dec. 17, 1880	20
2254	July 6, 1880	2152	Christian Steinmann	Swiss Alp	....do	Nov. —, 1880	20
2255	June 17, 1880	2084	C. Abendroth	Schulenburgh	....do	Nov. —, 1880	20
2256	June 15, 1880	2079	William Hahuke	....do	....do	Dec. —, 1880	20
2257	May 21, 1880	1987	G. Hillje	....do	....do	—— —, 1880	20
2258	June 15, 1880	2080	J. Mernitz	....do	....do	Dec. 20, 1880	20
2259	May 21, 1880	1990	W. T. Upton	....do	....do	—— —, 1880	20
2260	Sept. 13, 1880	2162	G. W. Everett	Cotton Gin	Freestone	Jan. 20, 1881	6
2261	Sept. 13, 1880	$2162\frac{2}{3}$	G. W. Ingram	....do	....do	Jan. 20, 1881	7
2262	Sept. 13, 1880	$2162\frac{1}{3}$	R. T. Kennedy	....do	....do	Jan. 20, 1881	7
2263	Dec. 15, 1880	5046	Job Sangbetham	....do	....do	Dec. 15, 1880	20
2264	Dec. 15, 1880	5047	Thomas Longbotham	Wortham	....do	Dec. 15, 1880	20
2265	June —, 1880	2120	M. S. Finch, sr	....do	....do	Nov. 30, 1880	16
2266	....	......	M. S. Finch	....do	....do	Dec. —, 1880	20
2267	July 8, 1880	2155	J. P. Lee	....do	....do	Dec. —, 1880	20
2268	July 8, 1880	2156	Lewis H. Lee	....do	....do	Nov. 6, 1880	15
2269	July 2, 1880	2139	F. G. Snapp	....do	....do	Dec. 20, 1880	20
2270	July 14, 1880	2168	H. M. Ramsay	Leesville	Gonzales	Dec. 20, 1880	20
2271	....	......	S. A. Cook	Denison City	Grayson	Nov. 2, 1879	18
2272	May —, 1881	4649	M. T. Brackett	Sherman	....do	May —, 1881	......
2273	....	......	M. S. Klum	....do	....do	May 4, 1881	20
2274	Nov. 26, 1879	2560	F. G. Stratton	....do	....do	Nov. 26, 1879	18
2275	Apr. 2, 1878	211	Dr. George Stratton	....do	....do	—— —, 1879	18
2276	Sept. 15, 1880	2372	Mrs. M. A. Wallace	do	....do	Dec 13, 1880	20
2277	May 7, 1880	1913	J. P. Stanfield	Whitesboro'h	....do	Dec. 14, 1880	......
2278	June 15, 1880	2082	A. H. Wilkins	....do	....do	Jan. 7, 1880	20
2279	Sept. 29, 1881	6476	....do	....do	....do	Jan. 7, 1881	20
2280	Dec. 15, 1880	5032	L. P. Barton	Houston	Harris	Dec. 15, 1880	20
2281	Dec. 17, 1880	5028	R. M. Bridges	....do	....do	Dec. 17, 1880	20
2282	Dec. 15, 1881	5034	J. F. Crosby	....do	....do	Dec. 15, 1880	20
2283	Dec. 17, 1880	5029	J. H. B. House	....do	....do	Dec. 17, 1880	20
2284	Dec. 15, 1880	5033	Samuel McIlhenny	....do	....do	Dec. 15, 1880	20
2285	....	......	S. C Tempoon	....do	....do	Dec. 20, 1880	20
2286	May 15, 1880	1955	E. H. Vasmer	....do	....do	Dec. 6, 1880	......
2287	Dec. 15, 1881	5031	J. T. D. Wilson	....do	....do	Dec. 15, 1880	20
2288	May —, 1881	4385	M. R. Geer	Marshall	Harrison	May —, 1881	......
2289	Oct. 25, 1880	2418	George Noble	....do	....do	Dec. —, 1880	......
2290	Dec. 3, 1880	2886	R. W. Thompson	....do	....do	Dec. 4, 1880	250
2291	....	......	A. M. Van Ness	....do	....do	May 2, 1881	25
2292	Dec. 14, 1880	5057	Ed. Kone	San Marcos	Hays	Dec. 15, 1880	20
2293	May 22, 1880	1993	A. J. Peel	....do	....do	Dec. 11, 1880	20
2294	Oct. 18, 1880	2412	Mrs. J. H. Raymond	Lawrence	Kaufman	Dec. 4, 1880	......
2295	Dec. 17, 1880	5027	J. S. Grinnar	Terrell	....do	Dec. 17, 1880	8
2296	....	......	Robert P. Mays	Brookston	Lamar	Oct. 28, 1879	20
2297	Nov. 26, 1879	982	W. H. Hancock, M.D.	Paris	....do	Dec. 4, 1880	......
2298	Nov. 26, 1879	2558	H. W. Lightfoot	....do	....do	Nov. 26, 1879	30
2299	Nov. 1, 1880	2427	R. J. Patton	....do	....do	Dec. 4, 1880	......
2300	Mar. —, 1881	4336	Dr. W. W. Steel	....do	....do	Mar. 1, 1881	20
2301	Dec. 17, 1880	5013	Jas. Walker	Halletsville	Lavaca	Dec. 17, 1880	20
2302	June 16, 1879	817	Samuel Bell	Kosse	Limestone	Nov. 28, 1879	18
2303	May 24, 1879	767	Volney Metcalfe	....do	....do	Nov. 28, 1879	18
2304	Mar. 13, 1880	1299	J. W. Fishburn	Mexia	....do	Dec. 4, 1880	20
2305	Sept. —, 1881	5729	....do	....do	....do	Dec. —, 1880	20
2306	Mar. 1, 1880	1298	P. H. Fishburn	....do	....do	Dec. —, 1880	20
2307	Dec. 15, 1880	5043	J. A. Gardiner	....do	....do	Dec. 15, 1880	20
2308	Mar. 13, 1880	1588	G. L. Hammeken	....do	....do	Dec. —, 1880	......
2309	Mar. 13, 1880	1587	John Kerley	....do	....do	Dec. 6, 1880	20
2310	Mar. 13, 1880	1585	H. M. Munger	....do	....do	Dec. 6, 1880	20
2311	Dec. 15, 1880	5040	E. R. Neal	....do	....do	Dec. 15, 1880	20
2312	Dec. 15, 1880	5041	R. L. Srapp	....do	....do	Dec. 15, 1880	20
2313	Dec. 15, 1880	5044	J. J. Walker	....do	....do	Dec. 15, 1880	20
2314	Dec. 15, 1880	5045	J. M. Waller	....do	....do	Dec. 15, 1880	20

Table showing by States the final destination of carp distributed, &c.—Continued.

TEXAS—Continued.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
2315	Mar. 13, 1880	1584	S. S. Walker	Mexia	Limestone	Dec. 6, 1880	......
2316	Sept. 1, 1880	2241	W. M. Bell	Tehuacana	do	Dec. —, 1880	20
2317	July 27, 1880	2186	A. M. George	do	do	Dec. —, 1880	20
2318	July 11, 1880	2163	C. F. Mercer	do	do	Dec. —, 1880	20
2319	Mar. 11, 1878	201	Dr. A. P. Brown	Jefferson	Marion	—— —, 1879	20
2320	Mar. 11, 1878	201	do	do	do	Jan. 8, 1881	300
2321	Dec. 15, 1880	5038	Leora Isaacs	Rockdale	Milam	Dec. 15, 1880	20
2322	Dec. 15, 1880	5035	J. W. Perry	do	do	Dec. 15, 1880	20
2323	Dec. 15, 1880	5037	E. G. Sims	do	do	Dec. 15, 1880	20
2324	Dec. 15, 1880	5039	P. B. Trey	do	do	Dec. 15, 1880	20
2325	Dec. 15, 1880	5036	W. B. Woody	do	do	Dec. 15, 1880	20
2326	....	......	B. C. Hinnant	Daingerfield	Morris	Jan. 12, 1881	20
2327	Nov. 26, 1879	2556	do	do	do	Nov. 26, 1879	50
2329	June 11, 1880	2066	T. A. Hayes	Birdston	Navarro	—— —, 1880	20
2330	....	......	F. W. Caruthers	Corsicana	do	Dec. —, 1880	20
2331	Oct. 12, 1880	2411	Charles H. Clayton	do	do	Dec. —, 1880	20
2332	Dec. 17, 1880	5017	M. Drane	do	do	Dec. 17, 1880	20
2333	Dec. 1, 1880	2864	John S. Gibson	do	do	Dec. —, 1880	20
2334	Dec. 17, 1880	5022	S. T. J. Johnson	do	do	Dec. 17, 1880	20
2335	Nov. 2, 1880	2437	Sullivan Merchant	do	do	—— —, 1880	20
2336	Dec. 17, 1880	5020	R. I. Mills	do	do	Dec. 17, 1880	20
2337	Dec. 17, 1880	5023	C. S. Morse	do	do	Dec. 17, 1880	20
2338	Dec. 17, 1880	5021	J. T. Sullivan	do	do	Dec. 17, 1880	20
2339	Nov. 11, 1880	2154	J. A. Townsend	do	do	Dec. —, 1880	20
2340	Aug. 23, 1880	2233	L. T. Wheeler	do	do	Dec. 20, 1880	20
2341	June 14, 1880	2075	Col. Henry Jones	Cross Roads	do	Dec. —, 1880	20
2342	May 17, 1880	1957	W. S. Robinson	Dresden	do	Dec. —, 1880	20
2343	Nov. 22, 1880	2877	T. C. Moore	Bremond	Robertson	Dec. 23, 1880	20
2344	Jan. 24, 1882	12692	W. H. Hamman	Calvert	do	—— —, 1881	......
2345	Apr. 20, 1880	1800	J. N. Still	Henderson	Rusk	Dec. 4, 1880	......
2346	Jan. 9, 1882	9389	James P. Douglas	Tyler	Smith	—— —, 1881	20
2347	July 27, 1880	2188	L. W. Crawford	Fort Worth	Tarrant	Dec. 12, 1880	20
2348	Feb. 15, 1879	639	Ephraim Dagget	do	do	Dec. 12, 1880	20
2349	Dec. 25, 1879	1045	M. A. Harris	Ripley	Titus	—— —, 1880	......
2350	May 15, 1880	1948	Wm. Brueggerhoff	Austin	Travis	Dec. 20, 1880	20
2351	May 22, 1880	1991	W. S. Carothers	do	do	Dec. 10, 1880	200
2352	Nov. 11, 1879	971	J. H. Dinkins	do	do	—— —, 1879	151
2353	Dec. 8, 1880	3209	English & English	do	do	Dec. 8, 1880	175
2354	Dec. 14, 1880	5055	James W. Hancock	do	do	Dec. 15, 1880	20
2355	....	......	A. W. Holz	do	do	Dec. 15, 1880	20
2356	July 15, 1880	2173	John B. Jones	do	do	Dec. —, 1880	20
2357	Dec. 8, 1880	3210	C. F. Millett	do	do	Dec. 8, 1880	10
2358	July —, 1881	6387	William Radam	do	do	Dec. 15, 1880	20
2359	May 17, 1880	1958	Chas. Von Rosenberg	do	do	Dec. 12, 1880	20
2360	June 8, 1880	2057	A. Scholtz	do	do	Dec. 20, 1880	20
2361	May 19, 1880	1971	Frederick Sterzing	do	do	Dec. 20, 1880	20
2362	Dec. —, 1880	3206	N. Van Bosinberg	do	do	Dec. —, 1880	25
2363	June 22, 1879	2094	E. A. Mehoffy	Will's Point	Van Zandt	Dec. 4, 1880	......
2364	Feb. 2, 1879	648	P. S. Clarke	Hempstead	Waller	Dec. 22, 1879	20
2365	Feb. 16, 1879	669	B. H. Bassett	Brenham	Washington	Dec. 2, 1879	40
2366	Dec. —, 1879	2582	C. R. Breedlove	do	do	Dec. —, 1879	20
2367	Feb. 16, 1879	670	R. N. Campbell	do	do	—— —, 1879	20
2368	....	......	Hon. D. C. Giddings	do	do	Dec. 13, 1880	40
2369	Feb. 16, 1879	667	do	do	do	Dec. 15, 1879	40
2370	....	......	A. Laurance	do	do	Dec. 17, 1880	25
2371	Feb. 16, 1879	668	Thomas W. Morris	do	do	Dec. 2, 1879	20
2372	Feb. 16, 1879	671	John Sayles	do	do	—— —, 1879	20
2373	Dec. 17, 1880	5015	G. Wirshey	do	do	Dec. 17, 1880	25
2374	May 19, 1880	1967	Crenshaw Carothers	Burton	do	Dec. 4, 1880	......
2375	Feb. 16, 1879	673	W. H. Billingsbe	Chapel Hills	do	—— —, 1879	20
2376	Apr. 9, 1880	1736	Benjamin Williams	Mobeetie	Wheeler	Dec. 4, 1880	......
2377	May 17, 1880	1959	Moses Wiley	do	do	Dec. 4, 1880	......
2378	Dec. 17, 1880	5014	William Elliott	Taylor	Williamson	Dec. 17, 1880	20
2379	May 25, 1880	2008	James A. Stinson	Quitman	Wood	Dec. 4, 1880	......
2380	May 6, 1880	1906	J. H. Kay	Hawkins	do	Dec. 4, 1880	......

VERMONT.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
2381	May 20, 1880	1980	F. I. Moore	Landgrove	Bennington	Oct. 29, 1880	......
2382	....	......	A. B. Ashley	Milton	Chittenden	Nov. 18, 1880	15
2383	Mar. 6, 1880	1449	H. A. Phelps	do	do	Nov. 18, 1880	15
2384	Apr. 12, 1880	1712	L. H. Spear	Braintree	Orange	Nov. 10, 1880	20
2385	Aug. 30, 1880	2342	J. W. Howard	Irasburgh	Orleans	Oct. 29, 1880	20

Table showing by States the final destination of carp distributed, &c.—Continued.

VERMONT—Continued.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
2386	July 3, 1880	2145	Spencer & Steward	East Clarendon	Rutland	Nov. 9, 1880	20
2387	May 10, 1880	1921	Joel Grout	Fayetteville	Windham	Nov. 16, 1880	15
2388	Apr. 28, 1880	1771	G. A. Leland	N. Springfield	Windsor	Oct. 29, 1880	......
2389	Apr. 19, 1880	1742	C. L. Paine	East Bethel	do	Nov. 18, 1880	15

VIRGINIA.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
2390	Mar. —, 1881	4211	George T. Garrison	Accomack C. H	Accomack	Mar. 20, 1881	25
2391	Feb. 9, 1880	1178	John Neely	do	do	Oct. 27, 1880	......
2392			do	do	do	Mar. 8, 1881	100
2393	Feb. 9, 1880	1172	John H. Wise	do	do	Oct. 27, 1880	......
2394			do	do	do	Apr. 4, 1881	50
2395	Mar. 18, 1880	1583	Richard T. W. Duke	Charlottesville	Albemarle	Nov. 16, 1880	16
2396	May 29, 1880	2015	W. W. Flannagan	do	do	Nov. 16, 1880	16
2397	Jan. 11, 1881	3393	Charles H. Harman	do	do	Mar. 16, 1881	50
2398	Mar. 16, 1881	3393	do	do	do	Apr. 19, 1881	19
2399			do	do	do	Apr. 25, 1881	20
2400	Nov. 4, 1879	953	L. S. Mason	do	do	—— —, 1879	16
2401	Nov. 15, 1880	2457	E. Peyton	do	do	Nov. 20, 1880	......
2402	Aug. 13, 1880	2208	John D. Watson	do	do	Nov. 16, 1880	16
2403	June 1, 1880	2040	M. W. Wallace	Yancey's Mills	do	Nov. 20, 1880	16
2404			S. B. Corbett	Alexandria	Alexandria	Nov. 12, 1880	20
2405	Apr. 15, 1880	1723	do	Arlington	do	Oct. 27, 1880	......
2406	Apr. 29, 1881	4209	William A. Young	do	do	Nov. 30, 1881	25
2407	May 12, 1880	1935	N. W. De Krafft	Jetersville	Amelia	Nov. 11, 1880	16
2408			Thomas S. Jeager	Sulphur Spr'gs	do	May 18, 1880	10
2409	June 22, 1880	2092	W. M. Evans	Amherst C. H.	Amherst	Nov. 16, 1880	16
2410	June 29, 1880	2108	H. B. Jones	Fishersville	Augusta	Nov. 20, 1880	16
2411	Apr. 1, 1881	3936	James R. Kemper	do	do	Apr. 11, 1881	40
2412	Dec. —, 1880	5198	James Baumgardner	Greenville	do	Dec. —, 1880	10
2413	Dec. —, 1880	5197	T. A. Lightner	do	do	Dec. —, 1880	16
2414	May 7, 1880	1915	D. P. Woodward	Staunton	do	Oct. 22, 1880	20
2415			W. J. Price	Fincastle	Botetourt	Nov. 16, 1880	16
2416	Mar. 30, 1880	1555	do	do	do	Nov. 23, 1880	16
2417	May 7, 1880	1914	H. M. Vaiden	Walthall's Store.	Brunswick	Nov. 27, 1880	......
2418	Dec. 8, 1879	2592	H. B. Nicholas	New Canton	Buckingham	Dec. 8, 1879	375
2419	May 12, 1880	1934	Bedford Alum and Iron Springs.	Bedford Spr'gs	Campbell	Oct. 27, 1880	......
2420	Dec. 15, 1880	5084	R. Mahew	Lynchburgh	do	Dec. —, 1880	16
2421			J. G. Mitchell	do	do	Jan. 30, 1881	25
2422	Mar. 26, 1881	3906	John J. Woodroof	do	do	Mar. 31, 1881	20
2423	Nov. 25, 1880	2879	John Gill	Millford	Caroline	Nov. 26, 1880	16
2424	Nov. 22, 1880	2875	J. W. Gill	do	do	Nov. —, 1880	16
2425	Nov. 22, 1880	2910	do	do	do	Dec. 2, 1880	50
2426	Mar. 30, 1880	1544	Prof. I. D. Coleman	Woodford	do	Oct. 27, 1880	......
2427	Oct. 29, 1880	2424	Shotwell Powell	Keysville	Charlotte	Nov. 17, 1880	20
2428	Apr. 14, 1880	1770	J. N. Armstrong	Culpeper	Culpeper	Nov. 27, 1880	......
2429	Dec. 15, 1880	5086	J. N. Armstrong	do	do	Dec. —, 1880	16
2430	Oct. 30, 1881	8297	Maj. James W. Green	do	do	Apr. 15, 1881	50
2431	Nov. 4, 1879	958	Major Grimsby	do	do	—— —, 1879	16
2432	Dec. 24, 1881	7743	Wm. G. Crenshaw	Rapid Ann Station.	do	Jan. 27, 1881	25
2433	Nov. 16, 1880	5098	W. Barry	Oak Forest	Cumberland	Nov. 16, 1880	16
2434	May 15, 1878	553	M. Flanagan	Flanagan's Mills.	do	—— —, 1879	20
2435	Nov. 16, 1880	5104	Geo. S. Bernard	Petersburgh	Dinwiddie	Nov. 16, 1880	50
2436	Apr. 8, 1880	1617	Esek Steere	do	do	Oct. 27, 1880	......
2437	Nov. 16, 1880	5105	Esik Stein	do	do	Nov. 16, 1880	16
2438	Mar. 31, 1880	1825	B. D. Wilson	do	do	Nov. 14, 1880	16
2439	May 10, 1880	1919	W. M. Field	San Marino	do	Nov. 16, 1880	16
2440	Mar. 21, 1881	3814	H. G. Otis	Clifton Station	Fairfax	Apr. 7, 1881	40
2441			Emanuel H. Jones	Fairfax	do	Apr. 22, 1881	20
2442	Apr. 12, 1881	4005	George W. Bell	Herndon	do	May 4, 1881	20
2443	Apr. 19, 1880	1748	Abner E. Doty	do	do	Nov. 18, 1880	16
2444	Nov. 6, 1880	3293	Joseph Gibbs	Pleasant Vall'y	do	Nov. 26, 1880	16
2445			A. P. Barry		Fauquier	Oct. 30, 1880	20
2446	Sept. 15, 1880	2373	R. H. Dulany	Upperville	do	Nov. 18, 1880	16
2447	Sept. 18, 1880	2357	Robert P. Barry	Warrenton	do	Oct. 27, 1880	......
2448	Feb. 22, 1880	1279	Herman Bartels	do	do	Oct. 27, 1880	......
2449			do	do	do	Nov. 9, 1880	24
2450	Apr. —, 1881	4204	Hugh R. Garden	do	do	Nov. 16, 1880	16
2451	Aug. 26, 1880	2224	do	do	do	Nov. 16, 1880	16
2452	June 9, 1881	4736	William Muller	do	do	Nov. 16, 1880	24
2453	Oct. 7, 1880	2393	do	do	do	May —, 1881	......

Table showing by States the final destination of carp distributed, &c.—Continued.

VIRGINIA—Continued.

Serial number.	Application filed.		Name.	Locality.		Delivery of carp.	
	Date.	Number.		Post-office.	County.	Date.	Number.
2454	May 18, 1879	938	Gen. W. H. Payne	Warrenton	Fauquier	Nov. 5, 1879	16
2455	Jan. 18, 1880	1167	Dr. H. M. Price	Antioch	Fluvanna	Nov. 16, 1880	16
2456	May 29, 1880	2017	J. W. Schultz	Stephenson's Depot.	Frederick	Nov. 26, 1880	10
2457	May 29, 1880	2019	Henry Stephenson	do	do	Nov. 26, 1880	16
2458			A. Pratt	Winchester	do	Dec. 13, 1880	20
2459			do	do	do	May 15, 1881	20
2460			P. Fatcher	do	do	Apr. 20, 1881	20
2461	Apr. 3, 1880	1652	James Thwaite	do	do	Nov. 27, 1880	
2462	June 19, 1878	347	Dr. Asa Wall	do	do	——, 1879	16
2463		955	Leonard P. Wheat	do	do	——, 1879	16
2464	Apr. 12, 1880	1826	Fred. J. Lindley	Hicksford	Greenville	Nov. 23, 1880	12
2465	Sept. 18, 1880	2358	A. M. Maclin	do	do	Nov. 22, 1880	12
2466	Mar. 30, 1880	1623	Thomas W. Goodrich	Rural Bower	do	Nov. 20, 1880	16
2467	Dec. 15, 1880	5083	James B. Denton	Hanover	Hanover	Dec. —, 1880	16
2468	May 3, 1880	1867	do	Junction	do	——, 1880	20
2470	Nov. 20, 1880	5117	John G. Andrews	Richmond	Henrico	Nov. 26, 1880	12
2471	Nov. 11, 1880	3313	Benjamin H. Berry	do	do	Nov. 12, 1880	16
2472	Oct. 25, 1880	2416½	H. M. Jackson	do	do	Nov. 2, 1880	16
2473	Jan. 24, 1881	7828	L. G. Johnke	do	do	Apr. 29, 1881	50
2474	Apr. 15, 1880	1639	W. J. Lynham	do	do	Oct. 27, 1880	
2475	Aug. 4, 1881	6101	do	do	do	Nov. 16, 1880?	10
2476	Nov. 16, 1880	5106	W. R. Marle	do	do	Nov. 16, 1880	16
2477	Oct. 12, 1881	6181	Samuel P. Moore	do	do	Nov. —, 1880?	10
2478	Feb. 16, 1880	1328	do	do	do	Nov. 16, 1880	10
2479	Oct. 25, 1880	2416	James B. Pace	do	do	Nov. 2, 1880	16
2480	Sept. 1, 1879	746½	A. L. Pedego	Horse Pasture	Henry	——, 1879	25
2481	Apr. 5, 1880	1680	James M. Price	Ridgeway	do	Nov. 16, 1880	16
2482	July 6, 1881	6102	E. M. Gresham	Carlton's Store	King & Queen	Apr. 20, 1881?	25
2483	Dec. 15, 1880	5080	Rev. R. H. Land	Stevensville	do	Dec. —, 1880	10
2484	Mar. 8, 1880	1580	do	do	do	Oct. 27, 1880	
2485	May 29, ——	2016	J. S. Pursell	Carlton's Store	do	Nov. 27, 1880	
2486	Feb. 1, 1880	1216	Charles Mason	Edge Hill	King George	Dec. 14, 1880	25
2487	Dec. 15, 1880	5081	E. O. Greenlaw	Greenlaw's Wharf.	do	Dec. —, 1880	30
2488			T. M. Pazon		Loudon	Oct. 13, 1880	20
2489	Dec. 13, 1880	3074	A. M. Chichester	Leesburgh	do	Jan. 31, 1881	50
2490	May 4, 1880	2003	Thompson Paxson	do	do	Nov. 18, 1880	18
2491			James F. Rinker	do	do	Dec. —, 1880	10
2492	Apr. —, 1881	4061	do	do	do	May 5, 1881	20
2493	Dec. 15, 1880	5089	Thomas Williamson	do	do	Dec. —, 1880	10
2494	Oct. 30, 1879	968	John G. R. Kalb	Lovettsville	do	Oct. 27, 1880	
2495			R. Welby Carter	Purcellville	do	Jan. 25, 1881	40
2496	Apr. 1, 1880	1472	E. P. McLean	Abbyville	Mecklenburg	Oct. 27, 1880	
2497	May 16, 1881	4583	William H. Dunlap	Chase City	do	Dec. 23, 1880?	20
2498	Feb. 16, 1880	1198	J. H. Lett	Stony Cross	do	Oct. 27, 1880	
2499	Nov. 4, 1879	951	Dr. M. G. Elzey	Christiansburg	Montgomery	——, 1879	10
2500	Feb. 29, 1880	1294	B. B. Dumville	Suffolk	Nansemond	Oct. 27, 1880	
2501	July 26, 1880	2184	Joseph Ligon	Massie's Mills	Nelson	Nov. 11, 1880	10
2502	July 19, 1880	2179	Washington Hunt	Capeville	Northampton	Nov. 27, 1880	
2503	Sept. 4, 1880	2345	W. H. Bridgeforth	Nottoway C. H.	Nottoway	Nov. 16, 1880	10
2504	Oct. 20, 1881	7887	Copeland D. Epes	do	do	Dec. 28, 1880?	40
2505	Feb. 12, 1880	1226	D. M. Somerville	do	do	Nov. 18, 1880	16
2506	Apr. 15, 1880	1637	Dr. G. G. Booth	Wellville	do	Oct. 27, 1880	
2507	Dec. 15, 1880	5082	James G. Field	Gordonsville	Orange	Dec. —, 1880	10
2508	Nov. 4, 1879	957	Dr. Grimes	do	do	——, 1879	16
2509			M. A. Miller	do	do	Jan. 9, 1881	20
2510	Mar. 29, 1882	13011	Dr. Wm. L. Hudson	Luray	Page	Apr. 18, 1881?	30
2511	Mar. 17, 1881	3798	W. O. Yager	do	do	Apr. 18, 1881?	50
2512	May 5, 1880	1903	T. J. Milnes		do	Oct. 27, 1880	
2513	July 6, 1880	2146	J. H. Hargrave	Chatham	Pittsylvania	Nov. 16, 1880	10
2514	Dec. 9, 1879	2596	W. E. Sims	do	do	Dec. 9, 1879	75
2515	Nov. 11, 1880	3309	Jacob Clark	Danville	do	Nov. 11, 1880	16
2516	Nov. 11, 1880	3310	W. P. Robinson	do	do	Dec. —, 1880	15
2517	Nov. 11, 1880	3311	Thomas A. Elliott	do	do	Nov. 11, 1880	10
2518	Oct. 2[illegible], 1881	8454	G. A. Creasy	Mount Airy	do	Oct. 17, 1880?	20
2519	Aug. 26, 1880	2234	do	do	do	Nov. 27, 1880	
2520	Nov. 25, 1880	3022	A. B. Moon	do	do	Nov. 30, 1880	
2521			B. Moore	do	do	Nov. 30, 1880	40
2522	Sept. 7, 1880	2370	Samuel L. Smith	do	do	Oct. 17, 1880	20
2523	Sept. 21, 1881	2362	William G. Davis	Whittle's Depot.	do	Nov. 26, 1880	14
2524	Apr. 17, 1880	1769	R. K. Dabney	Powhatan C. H.	Powhatan	Nov. 11, 1880	10
2525	Nov. 16, 1880	5092	John Austin	Farmville	Prince Edward	Nov. 16, 1880	10

Table showing by States the final destination of carp distributed, &c.—Continued.

VIRGINIA—Continued.

Serial number.	Application filed.		Name.	Locality.		Delivery of carp.	
	Date.	Number.		Post-office.	County.	Date.	Number.
2526	May 14, 1880	1945	John Houston	Farmville	Prince Edward	Oct. 27, 1880	.....
2527	Nov. 16, 1880	5091	Robert D. Miller	...do	...do	Nov. 16, 1880	16
2528	Oct. 20, 1880	2406	...do	...do	...do	Oct. 26, 1880	16
2529	May 6, 1880	1909	S. W. P. Sellers	Green Bay	...do	Nov. 11, 1880	16
2530			D. E. Mason		Prince George	Oct. 28, 1880	20
2531	Nov. 6, 1879	2483	R. B. Jones	Big Lick	Roanoke	Nov. 6, 1879	12
2532	Apr. 27, 1880	1817	Robert B. Moorman	...do	...do	Nov. 23, 1880	16
2533	Nov. 4, 1879	952	Col. Thomas Lewis	Salem	...do	—— —, 1879	512
2534			...do	...do	...do	Dec. 8, 1880	16
2535	Apr. 26, 1880	1866	William M. Dunlap	Kerr's Creek	Rockbridge	—— —, 1880	20
2536	Jan. 30, 1881	3467	D. M. Rodeffer	Baker's Mill	Rockingham	Nov. 26, 1880?	16
2537	Jan. 30, 1881	3457	J. D. Holsinger	Broadway	...do	Nov. 26, 1880?	16
2538	Aug. 13, 1880	2207	M. B. E. Kline	...do	...do	Nov. 26, 1880	16
2539	Jan. 30, 1881	3456	B. A. Myers	...do	...do	Nov. 26, 1880?	16
2540	Jan. 30, 1881	3460	Peter Rader	...do	...do	Nov. 26, 1880?	12
2541	Jan. 30, 1881	3458	David Shank	...do	...do	Nov. 26, 1880	16
2542	Nov. 15, 1880	3326	Samuel D. Wampler	...do	...do	Nov. 26, 1880	16
2543	Jan. 30, 1881	3466	W. C. Niswarner	Coote's Store	...do	Nov. 26, 1880	16
2544	Feb. 21, 1881	3816	John W. Easman	Cross Keys	...do	Mar. 20, 1881	50
2545	Feb. 21, 1881	3815	Peter F. Easman	...do	...do	Mar. 20, 1881	50
2546	Feb. 21, 1881	3817	Clarence Emmet	...do	...do	Mar. 20, 1881	50
2547		5093	E. A. Hering	...do	...do	Nov. 16, 1880	16
2548	Nov. 16, 1880	5094	A. B. Perkins	...do	...do	Nov. 16, 1880	16
2549	Nov. 9, 1880	3306	Solomon D. Heatwole	Dayton	...do	Nov. 26, 1880	16
2550	Nov. 6, 1880	3290	George W. Hollar	...do	...do	Nov. 26, 1880	16
2551	Sept. 8, 1880	2350	B. F. Michael	...do	...do	Nov. 16, 1880	16
2552	Nov. 8, 1880	3304	William J. Miller	...do	...do	Nov. 26, 1880	16
2553	Nov. 16, 1880	5103	E. Renbush	...do	...do	Nov. 16, 1880	16
2554	Nov. 16, 1880	5102	Samuel Shrum	...do	...do	Nov. 16, 1880	16
2555	Nov. 2, 1880	3289	John W. Bowers	Greenmount	...do	Nov. 26, 1880	16
2556	Nov. 6, 1880	3291	Peter Bonds	Harrisonburg	...do	Nov. 26, 1880	16
2557			C. Earrman	...do	...do	Apr. 21, 1881	60
2558	Nov. 20, 1880	5132	Michael Hollar	...do	...do	Nov. 26, 1880	16
2559	Nov. 20, 1880	5131	S. Moffert	...do	...do	Nov. 26, 1880	30
2560	Nov. 20, 1880	5136	Z. T. Puhe	...do	...do	Nov. 26, 1880	16
2561	Nov. 8, 1880	3300	Henry Pulse	...do	...do	Nov. 26, 1880	16
2562	Nov. 20, 1880	5134	E. Rhoades	...do	...do	Nov. 26, 1880	16
2563	Nov. 13, 1880	3314	James M. Rhodes	...do	...do	Nov. 26, 1880	16
2564			John H. Sandis	...do	...do	Nov. 26, 1880	16
2565	Nov. 8, 1880	3297	Michael Shank	...do	...do	Nov. 26, 1880	16
2566	Nov. 20, 1880	5133	M. M. Sibert	...do	...do	Nov. 26, 1880	16
2567	Nov. 20, 1880	5135	John J. Ward	...do	...do	Nov. 26, 1880	16
2568	Nov. 15, 1880	3330	Reuben Koontz	Lacey Spring	...do	Nov. 26, 1880	16
2569	Nov. 8, 1880	3296	George Life	McGaheysville	...do	Nov. 26, 1880	16
2570	Jan. 3, 1881	3464	A. W. Kountz	Mauzy	...do	Nov. 26, 1880?	16
2571	Nov. 15, 1880	3328	A. S. Rosenberger	...do	...do	Nov. 26, 1880	16
2572	Jan. 30, 1881	3461	Gideon Rosenberger	...do	...do	Nov. 26, 1880?	16
2573	Nov. 8, 1880	3305	Abraham Pirkey	Montevideo	...do	Nov. 26, 1880	16
2574	Nov 15, 1880	3329	Frederick Rhodes	Rockingham	...do	Nov. 26, 1880	16
2575	Nov. 16, 1880	5097	Daniel Miller	Spring Creek	...do	Nov. 16, 1880	16
2576	Aug. 2, 1880	2194	Jacob Thomas	...do	...do	Nov. 26, 1880	16
2577	Jan. 30, 1881	3465	M. Lohr	Tenth Legion	...do	Nov. 26, 1880?	16
2578	Nov. 16, 1880	5108	David Bowman	Timberville	...do	Nov. 16, 1880	16
2579	Nov. 16, 1880	5109	Solon M. Bowman	...do	...do	Nov. 16, 1880	16
2580	Nov. 20, 1880	5113	John M. Garler	...do	...do	Nov. 26, 1880	16
2581	Nov. 20, 1880	5114	Christ Haller	...do	...do	Nov. 26, 1880	16
2582	Nov. 20, 1880	5112	Israel Jones	...do	...do	Nov. 26, 1880	16
2583	Nov. 20, 1880	5111	Samuel H. Meyers & Son.	...do	...do	Nov. 26, 1880	16
2584	Nov. 20, 1880	5115	William A. Will	...do	...do	Nov. 26, 1880	16
2585	Nov. 20, 1880	5116	Lewis Will	...do	...do	Nov. 26, 1880	32
2586			J. F. Circle	Forestville	Shenandoah	Nov. 16, 1880	16
2587	Nov. 16, 1880	5100	Amos Peters	...do	...do	Nov. 16, 1880	16
2588	Nov. 20, 1880	5129	D. J. Andes	Moore's Store	...do	Nov. 26, 1880	16
2589	Nov. 20, 1880	5128	George E. Armentrout.	...do	...do	Nov. 26, 1880	16
2590	Nov. 16, 1880	5110	N. Armentrout	...do	...do	Nov. 16, 1880	16
2591	Nov. 20, 1880	5127	S. M. Bowers	...do	...do	Nov. 26, 1880	16
2592	Nov. 20, 1880	5126	John J. Coffman	...do	...do	Nov. 26, 1880	16
2593	Nov. 20, 1880	5122	John Getz	...do	...do	Nov. 26, 1880	16
2594	Nov. 20, 1880	5124	Evan Jones	...do	...do	Nov. 26, 1880	16
2595	Nov. 20, 1880	5123	William Jones	...do	...do	Nov. 26, 1880	16
2596	Nov. 20, 1880	5125	Abe Kropp	...do	...do	Nov. 26, 1880	16
2597	Nov. 20, 1880	5118	Jacob B. Miller	...do	...do	Nov. 26, 1880	16
2598	Nov. 20, 1880	5119	William H. Orebaugh	...do	...do	Nov. 26, 1880	16
2599	Nov. 20, 1880	5121	Daniel Will	...do	...do	Nov. 26, 1880	16

Table showing by States the final destination of carp distributed, &c.—Continued.

VIRGINIA—Continued.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
2600	Nov. 20, 1880	5120	Jacob Will	Moore's Store	Shenandoah	Nov. 26, 1880	16
2601	Nov. 16, 1880	5096	Mathias Zehring	Mount Clifton	do	Nov. 10, 1880	16
2602	Nov. 16, 1880	5095	Samuel Zehring	do	do	Nov. 16, 1880	16
2603	Dec. 15, 1880	5079	L. Triplett	Mount Jackson	do	Dec. —, 1880	16
2604	Dec. 15, 1880	3077	L. Triplett, jr.	do	do	Mar. 28, 1881	20
2605	May —, 1880	2114	Phillip S. Wise	New Market	do	Nov. 26, 1880	16
2606	Dec. 2, 1880	3031	A. Jackson	Woodstock	do	Dec. 2, 1880	......
2607	....	......	George H. Peyton	Fredericksburg.	Spottsylvania	Dec. 20, 1880	20
2608	....	......	C. Schultze	....	Surry	Oct. 30, 1880	20
2609	June 2, 1880	2341	B. F. Jarratt	Jarratt's	Sussex	Oct. 27, 1880	......
2610	Apr. 19, 1880	1743	Frank S. Robertson	Abingdon	Washington	Dec. —, 1880	16
2611	Apr. 19, 1880	1746	John G. White	do	do	Dec. —, 1880	16
2612	Apr. 20, 1880	1756	Milton White	do	do	Nov. —, 1880	16
2613	Apr. 6, 1880	1664	T. H. Massey	Oak Grove	Westmoreland	Dec. 1, 1880	25
2614	Mar. 26, 1880	1563	W. H. Costenbader	Potomac Mills	do	Oct. 27, 1880	......
2615	Mar. 26, 1880	1562	H. Horner	do	do	Dec. 13, 1880	25
2616	May 15, 1880	2673	Hon. R. E. Withers	Wytheville	Wythe	May 15, 1880	33
2617	Nov. 15, 1879	2502	C. M. Williams	do	do	Nov. 15, 1879	30
2618	Feb. 16, 1880	1360	Hon. R. E. Withers	do	do	Nov. 23, 1880	20
2619	Mar. 29, ——	1518	John McCormick	Yorktown	York	Oct. 27, 1880	......

WEST VIRGINIA.

Serial number.	Application filed. Date.	Application filed. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
2620	Mar. 29, 1881	3904	J. W. Post	Overfield	Barbour	Apr. —, 1881	40
2621	Nov. 17, 1880	5427	George E. Showers	Martinsburg	Berkeley	Dec. 2, 1880	......
2622	Jan. 12, 1880	2069	Alex. Campbell	....	Brooke	June —, 1880	60
2623	Apr. 23, 1880	1803	George C. Bloomer	Lewisburg	Greenbrier	Dec. 21, 1880	......
2624	Nov. 23, (?)	2054	George L. Peyton	White Sulphur Springs.	do	Nov. 22, 1880?	16
2625	....	......	Deaf, Dumb, and Blind Institute.	Romney	Hampshire	—— —, 1880	40
2626	....	......	C. S. White	do	do	Oct. 29, 1879	40
2627	....	......	W. L. Crawford	....	Hancock	June —, 1880	13
2628	....	6611	James Patterson	....	Hampshire	—— —, 1880	30
2629	....	......	W. H. Sale	....	do	—— —, 1880	20
2630	....	......	Z. Wilson	....	do	—— —, 1880	30
2631	Feb. 26, 1879	665	John R. Donehoo	Fairview	Hancock	Oct. 28, 1879	16
2632	....	......	do	do	do	Apr. 28, 1881	20
2633	....	......	Samuel Edie	New Cumberland.	do	June —, 1880	60
2634	....	......	J. S. Freeman	do	do	June —, 1880	60
2635	....	......	E. T. Alexander	Moorefield	Hardy	May 11, 1881	20
2636	May 23, 1880	1997	Garrett Cunningham	do	do	May —, 1880	20
2637	Feb. 23, 1879	1309	Luther Haymond	Clarksburg	Harrison	Dec. 21, 1880	......
2638	....	......	William Saddler	New Salem	do	Mar. 7, 1881	40
2639	Nov. 8, 1880	2449	John W. Williams	do	do	Dec. 21, 1881	......
2640	....	......	John A. Williams	do	do	Jan. 20, 1881	40
2641	July 10, 1880	2160	John A. Williamson	Ravenswood	Jackson	Nov. 16, 1880	......
2642	Feb. 26, 1880	1370	G. W. T. Kearsley	Charlestown	Jefferson	Dec. 21, 1880	......
2643	....	......	do	do	do	Dec. 6, 1880	50
2644	Nov. 14, 1881	7204	William F. Werrick	do	do	—— —, 1880?	20
2645	Feb. 5, 1880	65	Francis Yates	do	do	Dec. 20, 1880	......
2646	Apr. 6, 1880	1633	George R. Russell	Harper's Ferry	do	Dec. 21, 1880	......
2647	Sept. 15, 1880	6120	William J. Knott	Shepherdstown.	do	Nov. 18, 1880	20
2648	Apr. 6, 1880	1869	Thomas Locke	Summit Point	do	Apr. —, 1881	......
2649	Nov. 14, 1881	11548	Dr. Wm. J. Bland	Weston	Lewis	June —, 1880	9
2650	May 3, 1881	11550	J. J. Burns	Fairmont	Marion	May 3, 1881	10
2651	Apr. 22, 1881	11553	H. S. White	Bellton	Marshall	Apr. 22, 1881	75
2652	....	......	Bennet Fowler	Point Pleasant	Mason	Apr. 19, 1861	15
2653	Apr. 19, 1881	11556	W. R. Gunn	do	do	Apr. 9, 1881?	20
2654	Apr. 19, 1881	11558	D. S. Van Matre	do	do	Apr. 19, 1881	15
2655	....	......	J. L. Pierce	....	Mineral	—— —, 1880	30
2656	Apr. 22, 1881	11551	W. S. Cobun	Morgantown	Monongalia	Apr. 22, 1881	44
2657	Apr. 22, 1881	11552	L. W. Runner	do	do	Apr. 22, 1881	44
2658	Nov. 3, 1880	2705	O. Beorne	Sweet Springs?	Monroe	Nov. 3, 1880	75
2659	Oct. —, 1879	927	Senator Hereford	Union	do	Dec. 21, 1880	......
2660	Nov. 3, 1879	979	H. H. Hunter	Berkeley Sp'gs	Morgan	Dec. 21, 1880	......
2661	....	......	S. I. McColloch	....	Ohio	June —, 1880	60
2662	Apr. 20, 1881	11555	J. K. Botsford	Wheeling	do	Apr. 20, 1881	10
2663	Mar. 8, 1880	1471	Dr. H. McCoy	do	do	Dec. 21, 1880	......
2664	....	......	Dr. E. Halley McCoy	do	do	Apr. 20, 1881	10
2665	....	......	John Wright	do	do	June (?), 1880	6

Table showing by States the final destination of carp distributed, &c.—Continued.

WEST VIRGINIA—Continued.

Serial number.	Application field. Date.	Application field. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
2666			Andrew Mann	Forest Hill	Summers	—— —, 1880	20
2667	May 1, 1881	4648	R. C. Lilley	Jump'g Branch	do	—— —, 1880	20
2668	Nov. 30, 1881	11533	P. F. Bartlett	Astor	Taylor	—— —, 1880	30
2669	May 4, 1880	1898	do	do	do	Apr. 5, 1881	20
2670			Isaac Post	do	do	Apr. 28, 1881	20
2671			John A. Tumble	do	do	Apr. 28, 1881	20
2672			P. F. Bartlett	Flemington	do	Apr. 1, 1881	20
2673			J. H. Kahnst	Pruntytown	do	May 3, 1881	10
2674	Apr. 22, 1881	11554	J. W. Bradshaw	Burton	Wetzel	Apr. 22, 1881	60
2675			E. T. Bartlett	Parkersburg	Wood	Nov. —, 1879	30

WISCONSIN.

Serial number.	Application field. Date.	Application field. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
2676	Aug. 3, 1880	2198	Joachem Schildhauer	New Holstein	Calumet	Oct. 7, 1880	15
2677	Apr. 23, 1880	1768	A. J. Turner	Portage	Columbia	June 3, 1880	20
2678	Feb. 9, 1882	9597	Anton Link	East Bristol	Dane	Oct. 19, 1880?	15
2679	July 24, 1880	2183	do	do	do	Oct. 19, 1880	15
2680	Aug. 10, ——	408	H. W. Welsher	Madison	do	Oct. 27, 1880	450
2681			E. Reynolds	Metomen	Fond du Lac	June 13, 1880	20
2682	Jan. 31, 1881	3486	A. Cooley	Ripon	do	Mar. 11, 1881	31
2683	Apr. 15, 1878	228	A. Palmer	Boscobel	Grant	—— —, 1879	......
2684	June 1, 1880	2038	J. C. Sherwood	Dartford	Green Lake	Oct. 7, 1880	......
2685			John Fisher	St. Joseph	La Crosse	—— —, 1880	......
2686	Sept. 20, 1880	2361	J. J. Leavitt, M. D	West Salem	do	Nov. 10, 1880	20
2687			Christian Selk	Manitowoc	Manitowoc	—— —, 1881	20
2688			Mr. Smith	do	do	May 24, 1880	22
2689	Jan. 11, 1881	3413	Philip Pfaff	Pepin	Pepin	Jan. 29, 1881	25
2690			David Cross	Janesville	Rock	May 20, 1880	21
2691	Apr. 24, 1880	1754	C. L. Valentine	do	do	Oct. —, 1880	......
2692	July 9, 1881	4903	Paul M. Green	Milton	do	June 11, 1880	20
2693	Sept. 5, 1880	2346	Joseph W. Wood	Baraboo	Sauk	May 31, 1880	20
2694	May 22, 1880	1996	F. F. Wheeler	Waupaca	Waupaca	Oct. 7, 1880	......
2695	May 19, 1880	1968	Herman Gruhle	Fillmore	Washington	Oct. 7, 1880	......
2696	May 10, 1880	1922	James E. Heg	Geneva	Walworth	Oct. 7, 1880	......
2697	Aug. 6, 1880	2200	I. Gray	Marion	Waupaca	Oct. 7, 1880	......

MISCELLANEOUS.

Serial number.	Application field. Date.	Application field. Number.	Name.	Locality. Post-office.	Locality. County.	Delivery of carp. Date.	Delivery of carp. Number.
2698	Nov. 23, 1881	11539	James W. Windon	Point Pleasant	Mason, W. Va.	—— —, 1880	......
2699	July 12, 1880	2165	H. R. Solomon	Belle Plain	Callahan, Tex.	Dec. 6, 1880	......
2700			A. G. Redding	Macon	Bibb, Ga	—— —, 1879	......

NOTE.—The following corrections should be made in the foregoing list:

Serial No. 44. This item belongs in the Georgia list.
48. For Gainsville read Gainesville.
60. Application Nov. 14, 1878: No. 551.
91. For Danbury County read Fairfield County.
153. For J. Wilson Cooch read J. Wilkins Cooch.
154. For William Jinks Fell read William Jenks Fell.
176. For Admiral Ammen read Admiral Daniel Ammen.
205. For Saratoga read Buffalo Bluff.
207. Application Jan. 17, 1878: No. 173.
264. Application May 27, 1878: No. 306.
335. For Thormas B. Cabaniss read Thomas B. Cabaniss.
397. For Fish Club read Bellville Fish Club.
398. For H. H. Hartmanor read Herbert H. Hartmanor.
423. Application Oct. 26, 1879: No. 950.
434. For Protective Fishing Club read La Portle Protective Fishing Club.
483. Application Nov. 15, 1879: No. 992.
503. For J. W. Ferguson read James W. Ferguson.
517. Application No. 15,906.
521. For W. D. Kulpatrick read W. D. Kirkpatrick.
536. For J. H. Mulligan read James H. Mulligan.
553. For Munfordsville read Munfordville.
556. For John W. Matthews read John W. Mathews.
608. For H. Johnson & Sons read H. Johnston & Sons.
616. For J. W. Gatewood read James W. Gatewood.

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[NOTE.—The references are to the serial numbers in the list.]

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XL.—THE ARTIFICIAL FEEDING OF CARP.*

By Carl Nicklas.

The rational feeding of carp, and in fact of all fish, is possible only when, like the feeding of domestic land animals, it rests on a scientific basis; and when, in accordance with such scientific principles, the various nutritive matters are given to the carp in such proper proportion as its nature demands.

Starting from this point of view, I made an attempt as early as 1879, in my textbook of Pond-culture,† to establish a proper rule for feeding carp, and have reached the conclusion that the most rational one is to reckon to each 1,000 pounds of live carp 9 pounds of dry substance, containing 4 pounds of albumen, 2 pounds of hydrate of carbon, inclusive of fat, which would make the proportion of nutritive matter 20 to 1.

The proportion of nutritive matter is exceedingly close in itself, and still more so if compared with the food standard of land animals; and the demand for hydrate of carbon is consequently very small.

The quantity corresponds to the demand for food by 1,000 pounds of live hogs, if the greatest possible quantity of flesh and fat is to be produced. I was of opinion that I must make the standard quantity of albumen the same as that demanded by the hog, and I did this for the purpose of not making it too low, remembering the fact that the hog is the most voracious of our domestic animals, requiring more food in proportion than any other, and that the rapidity of its growth resembles that of the carp.

The proportion of nutritive matter, and the demand for hydrates of carbon, is based on calculations made with data obtained from careful observations made by Miller and Bausignault, as to the quantity of carbon received in the body and exhaled from it, and on practical feeding experiments made on a full grown sheep at the agricultural station of Wende.‡

According to Miller the following quantities of carbon were exhaled

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* *Künstliche Fütterung der Karpfen. Vom Güter-Inspector Carl Nicklas.* From "*Deutsche Fischerei Zeitung,*" Vol. V, Nos. 36, 38, 40, 43, 45, Stettin, September 5 and 19, October 3 and 24, and November 7, 1882.—Translated from the German by Herman Jacobson.

† *Lehrbuch der Teichwirthschaft*, pp. 201-225.

‡ Dr. E. Wolff: "*Fütterung der landwirthschaftlichen Nutzthiere,*" 1874, p. 35.

per 100 pounds of living weight during twenty-four hours: by the tench, 12 grams; the frog, 43.5 grams; man, 146 grams; a pigeon, 1370 grams; which would give the following proportion: 1:3.5=12:114.

These investigations show an astonishingly small quantity of carbon exhaled by fish, as represented by the tench. As the quantity of carbon exhaled varies according to the quantity received with the food, it results from these investigations—which agree with those made by Bousingault and in Wende—that the quantity of hydrates of carbon mentioned in the rule for feeding is hardly too low.

This small demand for hydrates of carbon is explained as follows:

1. In warm-blooded animals a considerable portion of the carbon received with the food is used for producing warmth, as in conjunction with the oxygen inhaled it occasions the burning of fat in the animal's body.

This demand does not exist in fish, as the body possesses no heat of its own; the demand for hydrates of carbon is limited to the quantity required for burning those substances which in the process of life become waste matter; and the quantity of carbon required for this purpose is of course very small.

2. Compared with land animals, fish make a small outlay of strength in locomotion. Even for standing quietly the land animal makes use of the muscles, and when walking requires them to support the weight of the body, but fish may float in the water or rest on the bottom without any special effort, because the water, its weight being equal to their own, holds them up.

This will become self-evident when we think of the ease with which a man can move a raft in still water, whilst on land he would hardly be able to move a single log of this same raft. It is true that swimming very soon tires a man, but this is not owing to the amount of strength required for the exercise, but simply to the fact that those muscles which come into play are not accustomed to this kind of exercise.

The circumstance that fish need much less exertion for their usual motions than land animals is an explanation of their small demand for hydrates of carbon and fat in their food. If, as is fully established, hard work does not so much promote the destruction of albuminous matter in the animal body as it intensifies the burning of hydrates of carbon (which demands an increase in the quantity of oxygen inhaled by the respiratory organs, which again creates greater heat, of which, however, a larger quantity is expelled from the body simultaneously with a greater evaporation of moisture), the contrary must be the case under the conditions of the life of fish.

3. The elementary composition of the carp also favors a small demand for hydrates of carbon, for, according to Dr. König, of Münster, this composition does not contain any substances free from nitrogen, and, according to Prof. E. Wolff, the carp only possesses 4 per cent. of extractives (*Extractivstoffe*). The difference between the investigations

of these two naturalists has no bearing on the question before us, and we will, therefore, leave it undecided which of the two is correct.

Compared with land animals, fish can, therefore, in an equal quantity of food, obtain more albuminous matter than the former, and thereby also attain to a larger growth, as, up to a certain limit, the formation of flesh and fat in the animal body increases with the increased quantity of albuminous matter contained in food.

If we further compare the proportion of the various nutritive substances contained in the natural food of the carp with that found by us as the standard of food, this standard will be found to be correct, even when viewed from this standpoint.

The natural food of carp consists of worms, maggots, larvæ, snails beetles, and other insects. Of these only the beetle and a number of other insects have been examined as to the quantity of nutritive matter contained in them, and they have been found to contain on an average 95 per cent. of nitrogenous matter, which would correspond to a nutritive proportion of 1:0.05. This proportion in cockchafers is given by Professor Wolff as 1:0.6.

As regards the worms, snails, &c., we possess no data, at least none have come to my knowledge. The effect of these animals when used as food for fish, however, shows that they must contain a considerable quantity of nitrogen. Thus the "*Deutsche Fischerei-Zeitung*," 1880, p. 25, maintains that by feeding trout on worms their weight can be increased in one year from three-fourths of a pound to 2½ pounds. Although this may be somewhat doubtful it nevertheless shows that the quantity of nitrogen contained in worms is very similar to that contained in beetles and other insects.

As regards feeding fish on snails, Dr. Molin says, in his *Rationellen Zucht der Süsswasserfische*, p. 13, that Commander Desme had a pond containing 150 hectoliters of water on his farm at Puygirard, in which he fed young salmon and trout on pounded snails, by which method of feeding he increased their weight on an average by 1 pound per fish. It may, therefore, be safely assumed that the quantity of nitrogen in snails is not materially less than that in worms.

As carp take the above-mentioned articles of food mixed, and as some of them consist exclusively of nitrogenous matter, and, as in most of them, the proportion of nutritive matter is a very close one, the standard of food laid down by me will also, from this point of view, have to be acknowledged to approach very closely to the natural food of the carp.

I have started my theory from the fact, which I know from actual experience, that the food of the carp is principally animal and not vegetable matter, and I find that in this I agree with most of the practical pisciculturists; but I differ from the views of Professor Nawratil (*Oesterreichisch-Ungarische Fischerei-Zeitung*, 1880, No. 35)* when he as-

* The *Fischerei-Zeitung*, formerly published in Vienna, is now discontinued, and not to be confounded with the first *Oesterreichisch-Ungarische Fischerei-Zeitung*.

serts that carp, from their third year, live principally on fresh and decaying vegetable matter. This is contradicted by the experience that they are easily raised in ponds which contain but few plants, and by the circumstance that, if aquatic plants formed the exclusive, or even principal food of carp, vegetation would, in some ponds, be utterly destroyed in a few days after they had been stocked with carp, or at any rate in a couple of years, as carp are particularly fond of young shoots, which, by the way, show a pretty close proportion of nutritive matter. Such an occurrence, however, I have never yet been able to observe, nor has it been observed by any other pond-culturist; whilst, on the other hand, it has frequently been observed that in carp-ponds vegetation becomes so rank and luxuriant that it has to be checked. As long as decaying vegetable matter has not been examined as to the quantity of nutritive substances contained in it, no opinion can be formed as to its suitableness for carp food.

My own observations have taught me that the carp only takes to vegetable food when absolutely no animal food can be procured. I have not yet been able to ascertain whether the carp actually eats and digests decaying vegetable matter, because all I have so far been able to observe has been that the carp often swallows such matter, but almost immediately ejects it again, perhaps after having devoured worms and insects clinging to such matter.

When I began to make the attempt to fix a standard of food, based on the analogous theory of food of land animals, but keeping in view the difference in the nature of fish and these animals, my object was to provide some aid to pisciculturists, and more especially to carp-culturists, in the artificial feeding of fish, so as to enable them, to some extent, to calculate results; and as this standard is not intended to furnish anything but such an aid, it is not necessary, in mixing food, to be absolutely exact in observing the quantities given by me, as, in mixing the food of domestic land animals, such exactness is not essential. The quantities should, however, approach those given by me, and it would be wrong to increase the proportions three or four fold. Even if such an increase (presuming there is a sufficient quantity of albumen) might not affect injuriously the nutritive quality of the carp food, it would at any rate involve a waste of hydrates of carbon, which, when they have to be bought, make the food more expensive, and will more or less decrease, or even entirely do away with the revenue. More than a hundred observations as to the food and feeding of carp, made by me in my piscicultural establishment, have proved to me the approximate correctness of my standard of food, but have also shown that the quantity of nutritive matter per 1,000 pounds of live carp, might be less than has generally been supposed.

Calculations made on the basis of my standard of food and given in my *Lehrbuche der Teichwirthschaft*, p. 219, showed that 1 kilogram of meat flour (*Futterfleischmehl*), which contains 0.692 kilograms of digesti-

ble albumen, and 0.112 kilograms of digestible hydrate of carbon produce 1 kilogram of albumen or 1.428 kilograms fish-flesh; later observations, however, have shown that even a smaller quantity is sufficient to produce this result.

Thus, experiments in feeding, made on a large scale on the estate of Plan, in Bohemia, and described in the above-mentioned *Oesterreichisch-Ungarische Fischerei-Zeitung*, 1880, No. 32, and 1881, No. 19, and carefully reviewed by me in the same journal, 1881, Nos. 23–30, showed that, in order to produce 1 kilogram of carp flesh, there were required 0.496 kilograms of albumen, which quantity is contained in 0.664 kilograms of meat flour; in other words, 1 kilogram of albumen produced, in round figures, 2.200 kilograms of carp flesh, and 1 kilogram meat flour produced 1.540 kilograms of carp flesh.

In making these experiments there were fed in a pond of 2.41 hectares 1,150 young fish, and in another pond of 4.56 hectares 2,240 young fish, averaging 30 grams apiece in weight. The food consisted of a mixture of meat flour, blood, malt, and flour. Nothing is said respecting the quantities of the different ingredients; all that we could learn was, that 4 kilograms albumen had been fed per 1,000 kilograms of living weight, and that the proportion of nutritive substances had been Nh : Nfr=1 : 1.95, and also that in this mixture the kilogram protëine had cost from 84 to 88 pfennig [about 19 or 20 cents].

These experiments, therefore, were only made respecting the quantity of albumen, on the basis of my standard of food, whilst the proportion of the nutritive substances was four times greater than the one prescribed by my standard, thus involving a very considerable waste of hydrates of carbon. But as the proportion of nutritive substances is increased, the amount of albumen remaining the same, the quantity of flesh produced will be smaller, and the above favorable result, obtained in spite of an increased proportion of the nutritive substances, only goes to show that, if this proportion had been smaller and more like the one prescribed by my rule, the fish-flesh produced would have been still greater.

My criticisms of these experiments were violently assailed by the superintendent of the Plan ponds, but they could not be effectually met by him, as he,leaving the subject proper, attacked the rule of feeding itself. In doing this, however, he did not venture to assail the scientific basis on which this standard rests, and consequently it could not be shaken. I have therefore left the article in question unanswered, and have quietly waited to see whether other pisciculturists would express their approval of the views contained in said article, to do which they were directly asked in the article itself. But so far no such approval has been given by any one, which, I think, sufficiently refutes the attack on my standard.

In that attack the following were the most serious objections presented: (I) that the quantity of food was too small; (II) that the required pro-

portion of nutritive substances could only be obtained if pure meat-flour was used; (III) that the cost of the food was too high compared with the results obtained.

We have already shown that the quantity of food is not too small, but, if anything, too great, and this has been proven by the experiments made, to the entire satisfaction of every one, except my critic.

The assertion that a quantity of food which is enough for that animal which is well known to need the greatest quantity of food, is not sufficient for fish, especially for carp, is so entirely at variance with the organism of fish, their powerful digestion, &c., that, if scientific researches ever prove the necessity of modifying my standard of food, the modification will certainly not consist in increasing the quantity of food, especially of albumen; although, on the other hand, I will not deny that there is a possibility that a larger proportion of the nutritive substances may be found to be better adapted to the purpose.

It is possible that as fish, compared with land animals, have very little demand for oxygen, a much larger portion of the hydrates of carbon, and of the fat received by the body—because not burned for the purpose of producing the heat of the body—is, instead of being expelled from the body as useless, utilized in the formation of flesh and fat. Too great a quantity will, therefore, act less injuriously on the utilization of the proteine, received with the food, than in land animals. We should not, however, be justified from this circumstance in drawing the conclusion that a larger proportion of nutritive substances than that found by me would be the most favorable and profitable proportion for the carp. It is doubtful whether sufficient light will ever be thrown on this subject by direct experiments on carp, because this would require a complete collection of all the excrements, and their chemical analysis, which, with fish, would be an exceedingly difficult matter, considering the fact that no way has as yet been found to make a complete collection of all the solid and fluid excrements of a domestic land animal like the hog.

All the experiments in feeding known to me have yielded higher results than the calculations based on my standard of food—0.7 kilogram of albumen for 1 kilogram of fish-flesh. I think that this was caused by the circumstance that, in mixing the food, I calculated the digestible albumen and the hydrates of carbon (according to Prof. Em. Wolff) which were produced by the digestion coefficient (*verdaungs-coëfficienten*) for the land animals, whilst it is well known that carp possess a much greater power of digestion and ability to extract than land animals. In using my standard of food this would only prove the calculations not exact, by increasing the profit, but not by diminishing it; and this would cause, not an increase, but a decrease of the standard nutritive substances.

These and similar thoughts rise in my mind in connection with this subject; but I am of opinion that all such considerations may be left to the investigation of specialists.

More than a hundred observations made in the piscicultural establishment of Mr. Kuffer, in Munich, have satisfactorily proven that the quantity of my standard was entirely sufficient. Mr. Kuffer daily feeds 100 to 125 kilograms of trout with only a few handsful of roe and fish entrails in addition to a bleak about 10 centimeters in length to each trout. Thereby he has, for more than twenty years, obtained a daily increase of 1 kilogram for each 100 kilograms live weight. In seeking to ascertain the weight of the dry substances and the nutritive matter contained in them per 500 kilograms live weight, in this kind of food and in the above quantities, one will come very near to the figures of my standard of food. In making similar experiments, principally with cheap, lean portions of meat which are generally used for feeding fish—following herein the rule laid down by a well-known authority, Livingston Stone (see Von dem Borne *Fischzucht*, first edition, p. 73), according to which 2.5 kilograms of meat produce 0.5 kilogram of fish flesh—one will arrive at similar results. The quantity of albumen contained in the above quantities agrees with my calculations that 1 kilogram of meat-flour produces exactly 1 kilogram of fish-flesh. All similar analyses of food which have come under my notice in a number of piscicultural and scientific journals, and which have produced particularly favorable results, have confirmed the practical correctness of my standard of food.

That the standard proportion of nutritive substances, Nh: Nfr=1:0.5, can only be obtained when pure meat-flour is fed, will become clear when one remembers that, according to Professor Wolff, the proportion of nutritive substances in meat-flour is only 1:0.4, and that consequently it needs an addition of some food containing hydrate of carbon in order to produce the desired proportion. That a mixture of food showing the required proportion may be obtained at a comparatively small expense will be seen from the following facts:

In the food used at Plau the kilogram of albumen is said to have cost 84 to 88 pfennigs [21 or 22 cents]. This must be considered dear; yet it cannot be owing to my standard of food, but to an irrational method of mixing the food. Nevertheless, in spite of this great expense, the results show a very considerable profit. It required 0.496, or, in round figures, 0.05 kilogram of albumen, costing 44 pfennigs [11 cents] to produce 1 kilogram of fish flesh. Calculating the price of 1 kilogram of carp at 100 pfennigs [25 cents], we get a net gain of 56 pfennigs [14 cents] per kilogram, which can only be accounted for by the method of feeding employed. If, however, the meat-flour had only been mixed with some binding soil, such as clay, which was frequently done in olden times, our calculations would be as follows: the price of meat-flour varies from 11 to 18 marks [$2.61 to $4.28] per hundred weight; supposing it to cost 18 marks [$4.28], the kilogram would cost 36 pfennigs [9 cents], and counting 4 pfennigs [1 cent] for preparation and soil, the cost would be 40 pfennigs [10 cents]. As we have seen above, 0.664 kilograms of meat-flour produce an increase of 1 kilogram. The kilogram of fish

flesh, therefore, cost 0.664 × 40, which is 26.56 pfennigs [about 6 cents]. In the market it would bring at least 100 pfennigs [25 cents], and in former times it would have brought at least 120 pfennigs [30 cents].

Let us now take a second mixture. Suppose that we feed to 500 kilograms of carp per day, 4.807 kilograms of fish-flour and 1.411 kilograms of wheat flour of the second quality. This contains 2.174 kilograms of albumen and 1.247 kilograms of hydrates of carbon, inclusive of fat; this latter substance reduced to the value of respiration (*Respirationswerth*). We now get 1:0.56 as the proportion of nutritive substances, which agrees with my standard. The cost of this mixture, including its preparation, which simply consists in adding water, making a tough paste, and trying it, would be as follows:

	Cent.
4.807 kilograms of fish-flour at 30 pfennigs [7½ cents]	36
1.454 kilograms wheat-flour at 44 pfennigs [11 cents]	16
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One kilogram of albumen, with the hydrates of carbon belonging to it, therefore, costs 96 pfennigs [24 cents]. If this produces 2.2 kilograms of carp flesh [at 43 pfennigs per kilogram] we get, supposing the price of carp to be 100 pfennigs [28 cents] per kilogram, a net gain of 57 pfennigs [14 cents] per kilogram of increase.

If we were to base this calculation on the result given in my manual, which is that 1 kilogram of albumen, with the corresponding quantity of hydrates of carbon, produces 1.428 kilograms of carp flesh, the cost of the kilogram would be 56.8 pfennigs [14 cents], and the net gain per kilogram of increase would, therefore, be 31.2 pfennigen [about 8 cents].

A third mixture of food is as follows: 2.890 kilograms of meat-flour and 1.451 of wheat-flour, containing 2.174 kilograms of albumen and 1.341 of hydrates of carbon, inclusive of fat, with a proportion 1: 0.7 of nutritive substances; the kilogram of albumen, at the above mentioned prices, would cost 72 pfennigs [18 cents]; the net gain per kilogram of carp flesh produced by food would, therefore, be 67.3 pfennigs [17 cents]. The proportion of nutritive substances is somewhat larger than in my standard, but may still be considered suitable.

A fourth mixture is as follows: 2 kilograms of wheat bran, and 9 kilograms of fresh blood, containing 1.971 kilograms of albumen and 1.012 kilograms of hydrate of carbon, inclusive of fat; the proportion of nutritive substances is therefore 1 : 0.594. Counting a kilogram of wheat bran at 20 pfennigs [5 cents] and a kilogram of blood at 5 pfennigs, this food costs, in round numbers, 85 pfennigs [21 cents], and the kilogram of albumen, in round numbers, 43 pfennigs [about 11 cents]; the net gain per kilogram of increase is therefore 80 pfennigs [20 cents].

Respecting this mixture, it may be mentioned that in the old *Oesterreichisch-Ungarische Fischerei-Zeitung* 1880, p. 139, it is stated that, during seven summer months an increase of 1.5 kilograms per fish was ob-

tained.* The mixture was prepared in the following manner. A paste was formed by the bran and blood, which was rolled into large balls. These balls were placed under the water near the banks of the pond, at a depth of about 30 centimeters, in places exposed to the sun. In the main pond the carp were therefore always fed in the same places, and the carp soon showed a preference for being fed in these places. Small aquatic animals also get their share of this food, and as they in their turn serve as food for the carp, nothing is lost; which also is true of most articles of fish-food.

A fifth mixture would be as follows: 1 kilogram of sprouting malt, 0.5 kilogram of wheat bran, 1 kilogram of meat-flour, 6 kilograms of blood; containing 2.040 of albumen and 1.048 kilograms of hydrate of carbon, inclusive of fat. In this the proportion of nutritive substances is 1 : 0.51.

The expense would be about as follows: 1 kilogram of sprouting malt, 10 pfennigs [2½ cents]; 0.5 kilogram of wheat bran, 10 pfennigs; 1 kilogram of meat-flour, 36 pfennigs; 6 kilograms of blood, 30 pfennigs; total, 86 pfennigs [21½ cents]. The kilogram of albumen would, therefore, be 43 pfennigs; yielding a net profit of 80 pfennigs [20 cents] per kilogram of increase.

If we were to base this calculation on the results above mentioned, as given in my manual—1 kilogram of albumen with the corresponding quantity of hydrate of carbon produces 1.428 kilograms carp flesh—the net gain per kilogram of increase would be: In the second mixture 31.2 pfennigs [about 8 cents]; in the third, 50 pfennigs [12½ cents]; in the fourth, 60 pfennigs, and in the fifth, also, 60 pfennigs. In considering the profits calculated in the above, we must remember that the market price of 100 pfennigs [25 cents] per kilogram of carp flesh is very low, whilst the cost of the food has been set rather high. Blood may be obtained from slaughter-houses for a few pfennigs a bucket, and often it is freely given away. It follows further that even if the results of the standard of food given by me were smaller than those mentioned above—which I am firmly convinced, however, will never be the case—there would still be considerable profit.

I could increase the number of recipes for food very considerably, but I think that those given will be sufficient to prove that mixtures of food can be produced with the proportion of nutritive substances given in my standard. As this proportion is very close, some articles of food containing a good deal of nitrogen should be added to all mixtures. As the most profitable of such articles of food, and those most readily taken

* Unfortunately, neither the quantity of the mixture nor its proportion is given; nor is it stated what was the productiveness of the pond; we, therefore, are not able to ascertain how much of the 1.5 kilograms obtained must be ascribed to the productiveness of the pond. It may be supposed, however, that the quantity of food is less than in the mixture mentioned just above, which corresponds with my standard of food. It must also be remembered that the fish were not fed every day.

by the carp, we will mention fresh and dry blood, with a proportion of nutritive substances Nh : Nfr = 1 : 0.1; lean horse-flesh with a proportion of 1 : 0.1; fish-guano or fish-flour, of 1 : 0.1; thick milt, of 1 : 0.2; dry refuse from starch factories [gluten], of 1 : 0.3; and meat-flour, of 1: 0.4. Of substances lacking in nitrogen we may mention potatoes, with a proportion of nutritive substances of 1 : 10.6. If we add to a food, or mixture of food, containing a proportion of nutritive substances of 1 : 0.5, about the same weight of potatoes, and to one of 1 : 0.2 about half the weight of potatoes, or to a certain weight of meat-flour, the fourth part of this weight in potatoes, or to a certain weight of fish-guano the same weight of potatoes, we shall come very near to the required proportion 1 : 0.5 of nutritive substances.

Such a mixture will become suitable for food, if boiled potatoes are mashed, then mixed with the articles of food, and mashed again repeatedly. During cool weather, or kept in a cellar, this food will keep for several weeks. When it is to be used, it is best taken out with a shovel or spade, broken into small pieces, and thus fed to the fish. Mixtures of meat-flour, fish-guano, horse-flesh, and similar substances, with potatoes, will, however, when thrown into the water, only hold together for a few minutes. These mixtures are only specially adapted to young fry, and they should be placed in the flat grassy edges of the ponds where the particles of food cling to the grass, and are found by the young fish. For larger fish these mixtures are not well suited, whilst solid food substances are not adapted to young fish. If one adds to such a mixture corresponding quantities of blood, thick milk, gluten from starch factories, worms, snails, or beetles, a tough paste may be made which will remain in the water for some time without dissolving. It may then be fed to the fish at once. If one wishes to keep it for some time, long strings are formed of this dough or paste by pressing it through the apertures of a sieve; these strings are cut in pieces of about the size of a pea, and are either dried in the sun and air, or baked. They are then well adapted to fish that are two years old or older.

Mixtures of fish-guano, meat-flour, dry meat chopped fine with flour or bran, are prepared by putting the first-mentioned substances in a barrel or any other suitable vessel and pouring boiling water over them till they will not absorb any more, whereupon the flour is added, and the entire mass is well mixed and kneaded. This food may be used as soon as it has grown cold, but it may also be kept for several days without any danger of its spoiling. This mixture may also be dried in the air, or be baked, when it will keep for a considerable length of time.

It will be well, especially when meat-flour is used, which does not contain any salt, to add a little salt—say about 10 kilograms coarse salt to 100 kilograms of food.

The necessity of maintaining the proper proportion of the nutritive substances, and to this end of using mixed food for carp, will exist in

all cases where artificially introduced food forms the exclusive food of the carp.

This is the case, for example, where feeding is intended to aid in stocking a pond with more fish than its natural conditions of food will allow, if a certain weight of carp is to be obtained. In this case, the food to be introduced would, so to speak, be the only food for the fish above the number naturally belonging to that pond. The case would be similar wherever fish are to be kept in a walled basin.

The more nitrogen the food contains, all the more profitable will the feeding be, for if more hydrates of carbon are fed to the fish than the proper proportion of the nutritive substances demands, these and the money spent for them is wasted, as they either pass from the body without being of any special use, or are used in the vital process without creating any flesh.

Wherever artificial feeding is merely to increase the productiveness of a pond, one may more or less, or even entirely, abandon the idea of mixing food for the purpose of widening the standard proportion of the nutritive substances (*i. e.*, of adding, in food not containing much hydrogen, the necessary hydrates of carbon to the food containing much albumen), as in nearly all organic matter the quantity of hydrates of carbon far exceeds that of the proteine, so that the fish can easily satisfy their demand for such hydrates of carbon from the natural resources of the pond.

The mixing of food, however, will be necessary, if it is not to be immediately eaten by the fish, in order to put the food in suitable shape, so as to prevent its losing its strength by being soaked in the water. Such preparation will also be necessary when it is to be kept for any length of time. For the sole purpose of meeting the last-mentioned object, it will suffice to mix the food with clayey or loamy soil. Thus, *e. g.*, by mixing a suitable quantity of water with meat-flour and some soil, an evenly mixed tough paste is produced, which is shaped into balls of the size of a pea or a filbert, or into small cubes, which are dried in the air. Food thus prepared only soaks very gradually in water, and takes a long time to dissolve entirely; which, however, happens but rarely, as the fish will devour it as soon as it has become somewhat soft.

It is not advisable to form this and other mixed food into thin cakes, similar to the Jewish Easter bread, which are broken and thrown into the water, as they will sink to the bottom, where it is difficult for the fish to get at them, and, sinking deeper into the mud, are finally lost. This is my own observation. For young fry, meat-flour, malt, bran, &c., may be scattered on the grassy banks of the ponds.

In designating those articles of food which contain the largest quantity of nitrogen, as the most profitable, I take it for granted that a person is exclusively limited to the *buying* of food. Wherever this is not the case, where other agricultural industries are carried on in connec-

tion with pond-culture, such as stock-raising, distilling, brewing, &c., which furnish a large quantity of refuse matter suitable for fish-food, which could hardly be put to any other use but feeding carp, it will be understood that this matter will be principally used as food, other substances, containing much nitrogen, only being employed to produce a food containing the proper proportion of nutritive substances. As the farmer in feeding his cattle is often obliged to make the best of what food he possesses, and to make lengthy calculations to obtain the proper mixture of food without having to buy much, thus, also, the pond-culturist will often be obliged to have recourse to the same plan.

In cases where the refuse matter above referred to cannot be sold, it may be counted at a much smaller price than it could be bought for, and in spite of the great waste of hydrates of carbon, the feeding of such matter will yet be profitable, whilst if food containing hydrates of carbon had to be bought, the profits would all be taken away by the high price of the proteine which would be needed.

Artificial feeding will be particularly advisable in ponds which do not contain much natural food, whilst in highly productive ponds, which at certain times are planted, or which receive the excrements of grazing cattle, &c., and which, as experience shows, if not too thinly stocked, may produce a very large quantity of fish, it will not prove profitable; at least I have never been able to observe any special effect of artificial feeding under such circumstances. The cause of it may be found in the circumstance that the stomach of the fish filled with the heavy food furnished by the pond, which requires a longer time for digestion, cannot receive any more food, and that, consequently, the fish does not feel any desire for it.

It cannot be denied that the regular feeding of fish in ponds has its peculiar difficulties, and requires much labor, especially when the ponds are large. But, if labor can be had, the expense should not be shunned, for the results will certainly pay for the labor and outlay, and the profits, as calculated in examples 2 and 3, will certainly not be diminished. At times it will even be possible to give the carp much food without incurring any great expense.

In the neighborhood of many, probably of most, ponds, cattle are grazing, and their excrements will be found in considerable quantity. It will neither be a difficult nor time-consuming labor to gather these excrements, which quickly dry in the sun and become the abode of many beetles, maggots, &c., in a wheelbarrow, and throw them into the ponds. It will be still better to gather these excrements only in summer, and keep them in heaps, sheltered from the rain, using them during the months of August, September, and October, when nature does not produce much suitable fish food.

The most profitable way will be to gather these excrements and throw them into the principal ponds about this time, when their fish are to be sold, and should have the greatest possible weight, and the expense of

feeding will thus quickly be repaid. Experience has shown that the quantity of food in the ponds decreases as the weather grows cooler, and in September one cannot count on more than about 10 per cent. of the total increase. If the carp, therefore, cannot be sold during that month, it is to be feared that in October the fish lose in weight—at any rate do not increase in weight. During the months above referred to, recourse should be had to artificial feeding.

Besides excrements of cattle, the flesh of dead animals can, in most cases, be easily procured, or blood and scraps of meat can be bought from the butchers at a cheap price. Such matter simply thrown into the water near the bank of the pond serves either directly as food for the fish, or maggots and worms form in it, small aquatic animals gather round it, and ample food is thus provided for the fish. With regard to dead animals it should be observed that large animals should not be thrown into the water whole, but cut in medium sized pieces, so as to avoid the danger of poisoning the water and thereby injuring the fish. Such pieces of flesh should always be about 20 to 30 centimeters under the surface.

Pieces of flesh, or small dead animals may also be placed free on poles stuck in the bottom of the pond. The maggots forming in such decaying animal matter will then fall into the water and become a prey to the fish.

Wherever there are distilleries, the slops from them may be thrown into the water near the bank of the pond, and will form a cheap and good food. Thus it was stated in No. 8 of the *Deutsche Fischerei-Zeitung*, 1878, that by feeding 60 liters of slops per week, in a pond measuring 500 cubic meters, from April 10 to November 9, 104 carp weighing each, on an average, 0.25 to 0.50 kilograms, reached an average weight of 1.375–1.625 kilograms.

Potatoes that are a little rotten, and other roots, may also be used for food.

In years when cockchafers are plentiful, they may be gathered and thrown into the pond, thus furnishing the carp with a favorite and strengthening food, and ridding the country of an insect which often becomes injurious to vegetation. Whenever there are breweries in connection with farms, their refuse, such as spoiled malt, husks, malt which has commenced to germinate, refuse from the barley, &c., may also be profitably employed as food for carp. Such matterial, when used in this way, will yield greater profits than when used for feeding cattle.

If there are clover fields or meadows near the ponds, the carp may be supplied with ample natural food by cutting grass, clover, or lucern, during the months between May and August, chopping it fine, pouring water on it, and then distributing it in small stacks in sunny places near the banks of the pond, so that it may be thoroughly warmed. On the following morning water should be again poured on these stacks, and, without being disturbed in any way, they should be again exposed to the

rays of the sun, which quickly heats them and produces putrefaction. During the following night already numberless beetles and other insects will creep into the steaming stacks and deposit their eggs. After three days the stacks are fairly alive with insects and their larvæ, and the stacks are then thrown, just as they are, into the water near the banks. They must, however, be entirely covered with water to the height of 20 to 30 centimeters. The exhalation from this decaying vegetable matter acts like a bait upon the carp. They eagerly seek it, devouring the insects contained in it, and also particles of the decaying matter. The places where the grass has been thrown into the water become gathering places for many other small animals, which breed there, and thus supply ample food for the carp. These places should be kept up. As grass can generally be had near the banks of ponds, this food is cheap and can be obtained with very little trouble.

Placing branches of pine, spruce, or juniper (branches of deciduous trees are injurious on account of the tannin contained in the leaves) in the water of ponds, especially those having but little vegetation, will also serve to increase the number of insects, as they become the breeding and hiding places of many of them. By lifting these branches from time to time out of the water, and shaking them, the insects contained in them are scattered in all directions and become an easy prey to the fish.

The feeding of carp will be all the more profitable, the more extensive the scale on which it is carried on, and the more the food agrees with the scientific principles of feeding animals.

If one restricts one's self to use substances for food in the manner indicated, which otherwise would not be of much use, which cannot be obtained regularly in sufficient quantities, much nutritive matter will—even if the results of this method of feeding are favorable—pass from the body of the fish without affording any use. Such irregular feeding can only be recommended in ponds containing larger fish; whilst in ponds where fish are raised, it would disturb the whole system of cultivation, and therefore prove injurious.

In order to reach the greatest possible results with the smallest possible quantity of food and at the least expense, or, at least, to approximately reach certain definite results of production, it is indispensable that the carp, like domestic land animals, should be supplied with a suitable quantity of food containing nutritive substances in proper proportion. As, so far, no other standard of food has been given but mine, as this has not been seriously attacked by any one, and, as in a general way it has been tested by my own experience, I see no reason why I should not conscientiously recommend it as a reliable guide in feeding carp.

Wherever it is the intention to reach certain definite results, especially when the feeding is to take place in feeding-ponds, the feeding process, if carried on in the wrong place, or in an improper manner, will

often do more harm than good; and in this case a guide for feeding carp, even if ever so imperfect, holding perhaps the same relation to it as the theory of the value of hay to the well-developed theory of feeding cattle, cannot be dispensed with.

With regard to the entire farming operation the feeding of carp can be made to subserve the following purposes:

I. To cause the fish in the growing-ponds to gain as much as possible in weight during the time immediately preceding the sale, viz, during the months of September and October.

If it is not the intention to catch a certain minimum weight of fish, it will be sufficient to give the fish, from time to time, food which may be on hand, and is otherwise useless; but even in doing this, certain regular periods should be observed, as it will invariably retard the growth of the fish if they are not fed on those days on which they have been accustomed to be fed.

If, however, it is the intention to reach, approximately, a certain definite minimum weight, food should be given in accordance with the standard. An example of this way of feeding is given on page 218 of my *Lehrbuch der Teichwirthschaft* (Manual of Pond culture).

II. To obtain young fry having the greatest possible weight.

The main question here is also whether a certain definite weight is to be approximated, or whether the object is merely to obtain heavier fry than could be obtained without feeding.

In the first case it will not be necessary to adhere strictly to the standard of food.

But if the young fry are, for example, to be advanced so much during the year of their birth as to reach a weight which otherwise they would not have reached till the second year, this object cannot be attained by feeding the fry in the hatching-ponds unless the quantity of fry is extraordinarily small, but the young fry must during the first year be transferred to special growing-ponds, and in them brought up to the desired weight, artificial food being used, according to the quality of the fry and the quantity contained in the pond.

If feeding has to be resorted to, the quantity of food should be adapted to the end in view by observing the feeding-rules.

III. To bring fry that have not attained the normal weight* during one year to the weight required for its transfer to the feeding-ponds during the following year.

Even in piscicultural establishments conducted on rational principles it may happen, in exceptional cases, that the fish of one or the other pond do not reach the normal weight aimed at for that particular year,

* By normal weight I mean the minimum weight per fish which the carp must reach in a year, so as to be ready for transfer during the following year, and so as to reach at the end of the entire period of raising the minimum weight aimed at for that period. This normal weight will therefore vary considerably, according to circumstances.

or that a part of the fish in one pond do not reach the same weight as the other fish in that pond. The cause of such uneven growth must generally be found in the circumstance that the fish with which the pond was stocked differed much in weight. Thus a difference of 50 grams, which would hardly be noticed with the naked eye, would, for example, in two-year old fish, which generally grow 150 per cent., result in a difference of 125 grams. For instance, if fish had been placed in the pond weighing from 250 to 300 grams, the former would reach a weight of 625 and the latter of 725 grams, showing a difference easily recognized with the naked eye. In fish, whose power to grow differs very much, this difference will be still more easily discerned.

Such irregularities should be corrected at once, as otherwise they may injure the system for years. In a well-organized and rationally-conducted piscicultural establishment it will not be possible to remedy the evil by diminishing the number of fish in each pond, because it is the object to raise every year an equal number of fish of equal weight, and therefore under otherwise equal conditions the number of fish in the different ponds must remain the same.

There are, therefore, only two ways, either to raise the young fry in ponds, outside of the farm proper, such as I have recommended in my manual, and which I have designated as "ponds at disposal" (*disponible Teiche*) (See p. 308, &c.), or to resort to artificial feeding.

It is self-evident that, for this purpose, the fish should be placed in one or several ponds without mixing them with other fish, either greater or smaller. If, for instance, one has in a growing-pond of the first class (calculated to raise, during a period of four years, fish of 1,260 grams weight) some fish which have not reached the necessary weight of 260 grams, but perhaps only 160 grams, the most rational plan would be—in case the natural method indicated above cannot be followed—to feed the fish, which have been retarded in their growth, so much during the following year as to cause them to reach the weight of 625 grams necessary for their transfer into another pond.

If, thereby, contrary to intention, a greater weight than the normal weight is obtained, this will, of course, do no harm whatever. Only one should then take the precaution to follow one of the fundamental principles of fish culture, viz, to keep fish of the same weight together and see to it that they do not mingle with those of different weight, as, in that case, the larger fish might injure the smaller ones; the only result will be that one will have some fish which exceed the normal weight, which, however, will be an advantage, as it will increase the price of such fish, and will therefore add to the income of the pisciculturist. As a general rule a minimum weight is agreed upon in the contracts for the sale of fish, and the buyer will generally be pleased to see some of the fish exceed this weight. In case the difference between the weight obtained and the normal weight is not very great; if, *e. g.*, one has, in a feeding-pond of the first class, fish weighing between 200 and

260 grams, it would seem advisable to omit the artificial feeding in the growing-ponds of the second class, because there will then be a greater probability that in these ponds they will reach the weight of 625 grams under natural conditions of food. If this expectation should not be realized one should make up for lost time in the sale-ponds; but, if it is realized, the expense of feeding the fish has been saved. But, as we have already remarked, a difference of 50 or 60 grams will hardly be recognizable.

IV. To make the period of raising as short as possible. If artificial feeding is to be introduced for the purpose of shortening the period of raising, which would be impossible under natural conditions, especially in ponds whose natural power of production is not very great, it is imperative that the feeding process should be carried on according to scientific principles; only in this way will it be possible to feed the fish without heavy expense, and to approximate a certain definite weight. This will apply principally to a three-years' period of raising.

If the period lasts four years, the feeding process should be so regulated, that—approximately, at least—in the feeding-pond of the first class a weight of 260 grams is reached during the second summer, a weight of 635 grams in the feeding-pond of the second class during the third summer, and a weight of 1,260 grams in the sale-pond.

One ought, of course, to be satisfied if these weights are only reached approximately. This ought to be self-evident, but I desire to make special mention of it so as to preclude the possibility of making any mistakes; and I would say still further that this does not only apply in certain special cases, but may safely be laid down as a general rule.

Above everything else, regard should be had in artificial feeding to the laws of natural growth, or rather to the power of growth possessed by carp during the different years of their life, for any violation of the laws of nature will be punished sooner or later by nature herself. Even in the artificial regulation of the growth of carp, the laws of nature should be closely observed.

The natural power of growth varies very much during the first year; it is 150 per cent. during the second year, 100 per cent. during the third, 50 per cent. during the fourth, and 33⅓ per cent. during the fifth year.

I must confine myself to giving these figures, as it would lead us too far to give the reasons therefor; possibly I may be privileged to give them in some future article.

Feeding should also be adapted to the productiveness of each pond, as shown by experience. The food should be adapted to the difference between the productiveness and the result aimed at.

During a three-year's period it will be better to raise the weight of the young fry to 260 grams during the year of birth than to raise the weight to 510 grams during the second year, which weight would have to be reached in order to keep up with the natural power of growth.

In following the first-mentioned plan, a good deal of food will be

saved, because, if properly aided, the power of growth is greatest during the year of birth. If, however, the desired weight has already been reached during the year of birth, one will also need less food during the second year, because the advance from 260 to 635 grams can be made, in most cases, in tolerably good ponds, without having recourse to artificial feeding. As the case is similar in the sale-ponds, it will be most profitable, if there is a sufficient area of growing-ponds to justify the taking of the young fry from the hatching-ponds during the year of birth, and placing them in the feeding-ponds, to place in the feeding-ponds during the year of birth. If there are not enough feeding-ponds, nothing can be done, of course, but to place the young fry in the feeding-ponds during the second summer, and endeavor to raise some of them to the necessary weight for the last pond (510 grams of a final weight of 1,260 grams is to be reached); in this case, however, the expense of feeding will be greater than in following the first-mentioned method.

A similar method of feeding has to be followed, if, with an equal number of fish, a greater weight is aimed at than the productiveness of the pond can produce. In this case only one way remains—artificial feeding; in *all* ponds, if the difference between productiveness and the demand is very great; if this difference is not very great, it will be sufficient to introduce artificial feeding in some of the ponds. The quantity of food should, in that case, be in proportion to the difference between the productiveness of the ponds and the weight to be reached.

V. To stock a pond with a larger number of fish than its productiveness and the object aimed at allow.

There will be nothing irrational in stocking one or more ponds with a larger number of fish than their productiveness will allow, if the ponds belonging to an estate are so large that the natural distribution of fish in different ponds, according to their age, cannot be properly kept up, and if, therefore, it becomes impossible to keep only fish of the same age in one and the same pond.

The extent of the different ponds may necessitate a larger area for the growing-ponds than properly belongs to them; or, on the contrary, it may happen that the sale-ponds are too large in proportion to the growing-ponds.

In the first case it would seem best to stock the growing-ponds according to their productiveness, in such a way that the fish in these ponds, at the end of their second year of growth—for the sake of clearness we will give an illustration by figures—reach the weight of 635 grams (which would correspond to a final weight of 1,260 grams). This latter weight, however, cannot be reached in the sale-ponds by the fish from the growing-ponds, because their area and productiveness are not sufficiently large for this purpose. This difficulty can only be overcome by giving so much food to the extra number of fish in the sale-ponds as to increase the weight to 1,260 grams. If, however, the sale-ponds are too large in proportion to the growing-ponds, it will be best, for the

purpose of deriving the full benefit from the sale-ponds, to stock the growing-ponds in proportion to the capacity of the latter; which, of course, would give them an extra number of fish, and then to raise this extra number of fish to the required weight by artificial feeding.

By not employing artificial food in the above-mentioned cases, the given pond area would not yield its fullest possible produce, which, of course, could not be considered a rational method of pisciculture. The cause of it is this, that for certain given conditions there is only one final weight which can be considered the most rational, and which will yield the greatest possible revenue; it is that weight which will insure, every autumn, the most quick and profitable sale of the carp.

VI. To change the weight of carp of a former period as quick as possible to the normal weight of carp in the succeeding period, thereby shortening the period of transition.

The transition from one period to the other always requires several years till it is fully accomplished. During these years the yield of the fisheries will be either greater or smaller than in former years. If greater, this result will be brought about by the circumstance that, compared with former years, larger and heavier fish get into the sale-ponds. The catching of a larger number of fish does not, therefore, increase the revenue, as it is caused by the stock from preceding years; if smaller, the cause of this must be found in the circumstance that in some years the final weight is not reached, and the fish, therefore, cannot be sold till the following year.

These irregularities are rather annoying, and the transition, if it is to be accomplished without any disturbance or delay, requires great attention. It is, therefore, to the interest of the pisciculturist to shorten the period of transition as much as possible, and this can only be done by artificial feeding. It is better, however, not to feed than to feed in the wrong place, as will appear from the following.

To shorten the transition from one period to another—as a general rule, from a longer to a shorter one—it is above everything else necessary to do away, as soon as possible, with the differences of weight of the fish, which they have reached in the years of growth of the former period, and gradually to cause them to reach those weights which are aimed at in the new period.

If pisciculture has been carried on systematically during the preceding years, it will be easy to ascertain which fish have to be fed artificially for this purpose. But, if this has not been the case, the first thing to be done is to arrange the stock on hand according to weight, to ascertain the number of fish of each weight, and put these data down, so as to get the necessary facts in the case.

For such a transition, however, neither the young fry, nor a portion of the same, should be fed artificially, but the required weight can, and must, at once be reached by a proportionate stocking of the ponds.

Unless one puts down these data in some sort of tabulated form, one

is very apt to make a mistake in the feeding, and instead of quickly reaching the weights required for the new period, and thus finishing the transition and perfecting the new period during the first year, this result will be still more delayed than would have been the case if artificial feeding had not been employed.

I will endeavor to illustrate this by an example from my own practice. Suppose a six years' period is to be changed to a four years' period, with a final weight of 1,250 grams. For this purpose there would be required for the sale-ponds, 12,700 fish—1,300 weighing at least 600 grams each per hectare; for the growing-ponds, of Class II, 12,700 fish—216 weighing at least 250 grams each per hectare; and for the growing-ponds of Class I, 12,700 young fry, 325 per hectare.

There are on hand from the preceding period:

		No. of fish.
Young fry:		
At 0.029 kilogram		18,760
Fish:		
At 0.113 kilogram	845	
At 0.143 kilogram	1,721	
At 0.169 kilogram	2,031	
At 0.181 kilogram	2,121	
At 0.249 kilogram	2,252	
At 0.280 kilogram	2,177	
At 0.341 kilogram	2,353	
At 0.467 kilogram	2,859	
		16,259
Fish:		
At 0.602 kilogram	1,683	
At 0.664 kilogram	1,900	
At 0.712 kilogram	2,712	
At 0.780 kilogram	2,722	
At 0.021 kilogram	3,497	
		12,514

(It should be observed that, in this case, there were actually about fifty different weights which, for the purpose of simplification, are here already distributed in groups, the average weight of which has been taken.)

If the six years' period had been preceded by a systematic course of pisciculture, the carp should, in this case,—where the weight of the young fry, when placed in the growing-ponds, was about 30 grams, and the final weight reached 1,280 grams,—have reached the following weights during the intervening years: in the first year of growth 155 grams, in the second year 342.5 grams, in the third year 635 grams, and in the fourth year 967.5 grams. I have to give these figures without the detailed calculations on which they are based, as this would lead us too far; but any one who has worked a six years' period will hardly doubt their correctness, as his experience will teach him that they are at least approximately correct, even if he should be inclined to smile at the idea of calculating such things with mathematical accuracy.

In supposing that in consistent and systematic pisciculture there are variations in these weights, *e. g.*, during the first year of growth from 120 to 200 grams, in the second from 300 to 400, in the third from 600

to 700, and in the fourth from 900 to 1,000, I think (at least my experience teaches me this) that one would go too far. In spite of this, however, we have very distinctly divided classes of fish before us, which at once suggest a six years' period.

If a four years' period is aimed at, with a final weight of 1,250 grams, the weights—all other conditions being the same—will be as follows: 274 grams at the end of the first year of growth, 640 at the end of the second, and 1,250 at the end of the last year.

As it can hardly be expected that those carp which do not have the minimum weight of 600 grams will in the sale-pond reach the final weight in a single year, all fish having less than 600 grams must, in the four years' period, be placed in the growing-ponds. The stock on hand for the sale-ponds is only 12,514 fish, whilst it should be 12,700.

In the growing-ponds of Class II no carp should be placed which do not weigh at least 0.250 kilogram a piece. Of those weighing from 0.249 to 0.467 kilogram there are on hand 9,541 which will certainly reach a minimum weight of 0.600 kilogram for the next year's stock for the sale-ponds. The number aimed at is 12,700. In order to reach this number we must, therefore, endeavor to bring 3,159 of the lighter carp up to 0.640, or at least 0.600, kilogram, which will not be very difficult to accomplish.

In order to raise the stock of the sale-ponds to the required number, 12,700, it will be necessary, as has already been stated, to raise the required number of carp weighing 0.467 kilogram by artificial feeding to the final weight. There will then still be 3,358 fish, varying in weight from 0.43 to 0.181 kilogram. The best plan will be to sell them; unfortunately there will not be many customers for such light weights. In the case before us a very large number, however, may be used to supply voids in some of the ponds. If there are ponds at some distance, or if a summer-course has been included in the system, these extra fish can, in some outside ponds, by feeding, be raised to the weight of the other fish. It would not do to place them in the growing-ponds, as fish placed in these ponds should have the same normal weight as the stock of such ponds.

If one has no ponds of one kind or the other at one's disposal, all that can be done is to overstock a suitable area of the growing-ponds of Class I and Class II, in order to obtain ponds for raising these extra fish, and to neutralize this overstocking by artificial feeding. If the transition from one period to the other is to be hurried it will be better not to use any artificial food at all than to feed artificially in the wrong place. In the case in question several thousand young fry have, by feeding, in one year been raised to a weight of 0.500 kilogram, and the feeding of the heavier fish has been omitted in order to enter the new period as soon as possible. Thereby the perfecting of the transition is considerably delayed.

If, instead of aiming at 0.500 kilogram, the feeding had only aimed

at about 640 grams, this would still have been a rational system, because then the fish would have been sufficiently matured for the sale-ponds. But if they only weigh 500 grams they cannot be placed in the sale-ponds with any hope of success, unless one intends to adopt, at least for one part of the fish, a five years' period; and, on the other hand, these fish are too heavy for growing-ponds of Class II.

In the case in hand I had expressed my doubts (in view of the natural power of growth and the quantity and quality of the food) that the 500 grams would be reached, and these doubts have proved to be well founded. From a later communication it appears that in one pond only 390 [490?] grams were reached, viz: 404 grams with 17,000 fish, and 550 grams with 100 fish; and in a second pond, on an average, 681 grams, viz: 500 fish weighing 666, and 420 fish weighing 857 (?) grams; after 608 fish out of the total number of 1,150 had been removed. There is no doubt that even if the normal quantity of fish had been removed, no greater weight would have been obtained than in the first pond.

Here the unequal growth is a striking feature. In my opinion the matter is sufficiently explained by the circumstance that the fish were not of a pure breed, but were a mixture of mirror carp, leather carp, and hybrids of other carps, and that the fish, when placed in the pond, very probably differed considerably in weight. Another, and not less weighty reason, seems to be the circumstance that the fish did not all derive the same benefit from the food thrown into the ponds. As the food used softened very slowly, and was inconvenient for the carp to take, the fish could not be induced to come and be fed in flocks, as they are generally wont to do, and take the food at once; but they only occasionally seemed to come and see whether there was anything for them to eat. It can easily be imagined that, under these circumstances, some fish came often, and others but rarely. At least my own personal observations have taught me this. If, on the other hand, one waits till the fish all gather—and it is known from long experience that, if fish are accustomed to be fed daily at the same time and place, they will acquire the habit of flocking together at the accustomed time—and then throws the food into the pond, so that it is immediately eaten by the fish, they will all get very nearly an equal share. Those which get more in the beginning, will, when they have had their fill, go away and let others get some food. It will therefore be best, in order that all the fish may get their share, not to throw all the food into the pond at one and the same time. Nor should the food be thrown in in small pieces, one by one, for then only the stronger and swifter fish would have a chance to get anything; nor all in a lump. If these rules are observed, artificial feeding will result in tolerably even growth of the fish. Feeding fish has to be learned like everything else, and experience will be the best teacher. Any one may easily convince himself of the truth of the above remarks.

To return to the transition from one period to the other, it may be expected that the fish in the sale-ponds will reach the final weight, and the young fry the weight of about 270 grams, required for the intended four years' period; in the growing-ponds of Class II, however, a great many carp should be placed which probably, under ordinary circumstances, will not reach the weight of 640 grams required for their being placedin the sale-ponds; and it would therefore be doubtful whether they would reach the final weight during the following year. There will be, at any rate—

	No. of fish.
At 0.181 kilogram	2,121
At 0.169 kilogram	2,031
At 0.143 kilogram	1,721
At 0.113 kilogram	845
Total	6,718

It will be evident that if these 6,718 fish had been over-well fed, they would have reached the weight of 640 grams, and the four years' period would have been perfected already during the following year; for then the growing-ponds of Class I would have received young fry, those of Class II fish weighing on an average 270 grams, and the sale-ponds fish weighing 640 grams; whilst, owing to the feeding of the young fry, the transition was delayed, and thus this one year, at any rate, was lost.

APPENDIX F.

MISCELLANEOUS.

XLI.—REPORT OF A TRIP OF EXPLORATION IN THE CHESAPEAKE BAY.

By J. W. Collins.

[Made in the spring of 1882 by the steamer Fish Hawk, Lieut. Z. L. Tanner, commanding. *]

Leaving Washington at about 1 p. m. February 25, we steamed down the Potomac and anchored that evening in Cornfield Harbor, at Point Lookout. The weather being fine the following day we began operations by setting a gang of nets on the southwest side of the Potomac in 5 fathoms of water, about 3½ miles SSW. one-half S. from Point Lookout Light. Nothing whatever was found in the nets when they were hauled on the following morning, except a large number of Medusæ (sun-jellies, both red and white). Monday evening we set four nets off Barren Island in about 20 fathoms of water, and two in the Patuxent River. The latter were put out near the ship, Drum Point bearing N. by W. about one-half mile distant. Nothing was caught in the river; but about 20 young menhaden (*Brevortia tyrannus*) were taken in the nets set off Barren Island. These fish, with the exception of the largest, we have preserved in alcohol. They vary in length from about 3 to 8 inches, and were caught by the mouth, the twine passing in between the upper and lower jaws, after which they became more firmly entangled in the meshes. The next set we made off Smith's Point, and off Point Lookout Spit, on the evening of the 28th of February. In the first-named locality we set four nets in from 4 to 6 fathoms, while two nets were moored to the westward of the spit buoy at Point Lookout in 7 to 8 fathoms. During the night the wind breezed up strong from the southeast, making it quite rough in Cornfield Harbor, where the ship was anchored. Therefore, at about 4 a. m. March 1, we got under way, ran up the Potomac a few miles to smoother water, and anchored about an hour before daylight off Smith's Creek. After we anchored a dense fog shut down, and did not clear off until about the middle of the forenoon, when, the wind still blowing fresh and weather looking stormy, we weighed our anchor and ran into Smith's Creek for a harbor.

* A brief account of this trip by Captain Tanner has been published in the United States Fish Commission Bulletin, volume II, 1882, p. 133.—Editor.

When we hauled the nets yesterday morning we found that the sea and tide had parted the head rope of one of those off Smith's Point. This left the whole string to swing free with the tide to one mooring (a 60-pound boat anchor), and the consequence was that the nets dragged over the bottom, catching some oysters in the twine, and finally drove afoul of the anchor and anchor-line, with which they became so badly entangled that two of them, the two best fishing nets we had, were very much torn, and another, which we have since repaired, had the cork-line parted and was also torn considerably. It is possible that we may be able to partially repair one of the others, a fine-twine shad-net, but it is somewhat doubtful. Last night we set four nets off the southern end of Tangier Island, but found nothing in them this morning except sea-weed and grasses, with which they were literally filled. The tide runs very strong in all the localities we have visited so far, and I find that setting gill-nets at anchor is anything but an exact science. I have endeavored, as much as possible, to "lay out" the apparatus partially across the current, and so as to intercept any fish coming in or going out of the bay, rivers, and sounds, but in most cases this has not been even partially successful, the tide sweeping nets, boat, and all in whichever direction it chanced to run. The distance at which the nets are set from the bottom is also very much affected by the swift running water, and, even with the greatest care, nothing like definite results can be arrived at. I will add that for this work it will be necessary to have some new shad-nets, and that they should be hung to stouter lines, so that they can sustain the strain that is brought to bear on them. I would also mention that I was somewhat deceived about the nets. Several of those that were put down on the list as shad-nets I find are whitefish-nets, and others that we took aboard from the navy-yard, and which I understood were for cod, are also whitefish-nets. A long, fine-twine shad-net we took from the armory, and a large mackerel-net, though, perhaps, strong enough for ordinary purposes, have been used considerably, and were hardly fit to bear the extraordinary strain, wear and tear to which they must be subjected in these experiments. Those are the nets which were torn so badly off Smith's Point during the storm. As the case now stands we have a surplus of whitefish-nets (eleven in number), but a sad lack of shad-nets, upon which, of course, in an investigation of this kind, we chiefly depend. However, I think we will be able to tell pretty definitely whether or not there are any fish in the bay. The dredgings have shown but little to attract fish, and scarcely anything has been caught in the surface tow-net. In fact I am firmly convinced that there are no fish in the waters we have visited, except at Barren Island, where the beam-trawl brought up young menhaden, young alewives, and other young fish not yet identified.

I have made a list of the nets, by which each has a number and a corresponding mark. Under the number on the list the length, depth, and size of mesh are given. By this arrangement we need only to make

a note of the number of the net set, and by referring to the list we can see what it is.

The officers and men seem disposed to do everything possible to aid me. Captain Tanner detailed four men to help me with the nets and to manage the launch.

FORTRESS MONROE, *March* 3, 1882.

After leaving Fortress Monroe we ran over to Cherrystone Inlet on the afternoon of the 3d. We set four nets, viz, two whitefish-nets, a trammel-net, and a menhaden-net, about one-fourth mile W.SW. from the buoy off the entrance to the inlet, the depth of water being about 22 fathoms. The apparatus was put out between 5 and 6 o'clock p. m. Two of the nets (the trammel and menhaden nets) were set close to the bottom, the others nearer the surface, the last end of one of the whitefish-nets being sunk only 5 fathoms.

The next day after the nets were put out, as I wrote you at the time, the wind blew so strong from the northwest that it made a rough sea and prevented our making any attempt to get the gear.

When hauled on the morning of the 5th, it was found that the nets had drifted with the tide into 11 fathoms of water, one and a half miles northwest one-half west from where they were set. They were drifted into a pile around the buoy attached to the large boat anchor, which weighs 60 pounds, and were badly snarled. We lost two small anchors.

One menhaden, 6 inches long, was caught in the trammel-net, and 50 dogfish (*Squalus acanthias*) were taken, most of them being in the two nets nearest the surface. The stomachs of twenty of the dogfish were taken out and preserved in alcohol by Dr. Kite, and six fish were put on ice, three of them being males and three females. The ovaries appeared to be undeveloped.

After the nets were hauled, Captain Tanner ran across to York River, and that evening, a little after 5 o'clock, we set the shad-net (which in the mean time had been repaired), the trammel and menhaden nets in from 4 to 5 fathoms, Too's Point light-house bearing about east a half-mile distant. The upper edge of the shad-net was at the surface, the lead-line, of course, being near the bottom. The other two nets were placed from near the surface to the bottom.

When hauled on the morning of the 6th, nothing but sun-jellies were found in the nets, which had drifted slightly with the tide, notwithstanding they were heavily anchored.

Although it is probable a limited number of shad would be taken if present, it seems to me as if comparatively poor results can be obtained with anchored nets where there is such a strong tide as we have found in the Chesapeake. But there is apparently no other way of trying the deep holes, since drifting nets, even if set in deep water, would soon be carried into shoaler localities. The difficulty with anchored nets is that though they may be prevented from drifting by the use of very

heavy moorings, the twine must be floated out nearly horizontal if set across the current, or else carried up around the cork-line if the nets are put out with the tide. For a short time on the slacks, however, the nets may hang all right, providing they have not changed their positions during the run of the tide.

Leaving York River yesterday morning we ran over to the deep hole off Cherrystone, and had three sets with the beam-trawl. We caught many young hake (*Phycis regius* and *P. chuss*), some young spot (*Liostomus obliquus*), several species of flounders (all of small size), five or six skate (*Raia*), two dogfish, and several other kinds of small fishes and crustacea.

Later we proceeded to Saint Jerome, which we reached yesterday afternoon between 3 and 4 o'clock, and sent a boat ashore for the mail. In compliance with orders there received, Captain Tanner came here last evening, and will go to Washington to-day.

I have made daily reports to Captain Tanner in regard to the setting and hauling of the nets, and he has full details of the dredgings, &c.

ANNAPOLIS, MD., *March* 7, 1882.

XLII.—LIST OF THE FISHES DISTRIBUTED BY THE UNITED STATES FISH COMMISSION.

By Tarleton H. Bean, M. D.

I beg leave to present herewith a list of the fishes which receive attention from the United States Fish Commission, giving the oldest available specific name of each species as far as this can be determined at present. The name of the striped bass, *Roccus lineatus*, is in doubt; it seems probable that we must use Mitchill's name (*striatus*) instead of *lineatus*, the specific name *lineatus* being, apparently, not available until we reach Cuvier and Valenciennes in 1828. The synonymy of species which have been introduced from Europe is borrowed, for the most part, from Günther's catalogue. For American authors the references have all been verified. No attempt was made to furnish a complete synonymy, only the principal works having been consulted. The distribution of the species is briefly indicated.

1. Solea vulgaris Quensel. Sole.

Pleuronectes solea Linné, Syst. Nat., I, 1766, p. 457.

Solea vulgaris Quensel, Vet. Akad. Handl., 1806, p. 467; Günther, Cat. Fish. Brit. Mus., IV, 1862, p. 463.

Coasts of Europe. Attempts were made to introduce it into America by the U. S. Fish Commissioner in 1878, 1879, and 1880.

2. Rhombus maximus (L.) Cuv. Turbot.

Pleuronectes maximus Linné, Syst. Nat., I, 1766, p. 459.

Rhombus maximus Cuv., Règne Anim., II, 1817, 222; Günther, Cat. Fish. Brit. Mus., IV, 1862, p. 407.

Coasts of Europe. Account of introduction. Report, Part IX, LIV.

3. Gadus morrhua L. Cod.

Gadus callarias Linné, Syst. Nat., I, 1766, p. 436 (young); Günther, Cat. Fish. Brit. Mus., IV, 1862, p. 329; Jordan & Gilbert, Bull. 16, U. S. Nat. Mus., 1883, p. 804.

Gadus morrhua L., Syst. Nat., I, 1766, p. 436; Günther, Cat. Fish. Brit. Mus. IV, 1862, p. 328; and of recent American writers generally.

Morrhua Americana Storer, Rep. Fish. Mass., 1839, p. 120; De Kay, Nat. Hist. N. Y., I, 1842, p. 274, pl. XLIV, fig. 140.

North Atlantic and Pacific; on the coast of the United States extending southward to Virginia; in the Pacific, from Puget Sound northward to the ice-line in Bering Sea and westward to the Okhotsk.

4 Scomber scombrus L. Mackerel.

Scomber scomber L., Syst. Nat., I, 1766, p. 492; Schn. ex Bloch, Syst. Ichth., 1801, p. 24; Günther, Cat. Fish. Brit. Mus., II, 1860, p. 357.

4. Scomber scombrus L., continued.

Scomber scombrus CUV. AND VAL., Hist. Nat. Poiss., VIII, 1831, p. 6; GOODE, Game Fishes U. S., 1879, part five, p. 21, with colored plate; JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus., p. 424, and of most American authors at the present time.

Scomber vernalis MITCHILL, Trans. Lit. and Phil. Soc. N. Y., I, 1815, p. 423; (DE KAY, Nat. Hist. N. Y., I, 1842, p. 101, pl. XII, fig. 34); STORER, Syn. Fish. N. A., 1846, p. 90.

North Atlantic; credited also to the Pacific as an occasional visitor.

5. Scomberomorus maculatus (Mitch.) Jor. & Gilb. SPANISH MACKEREL.

Scomber maculatus MITCHILL, Trans. Lit. and Phil. Soc. N. Y., I, 1815, p. 426.

Cybium maculatum GÜNTHER, Cat. Fish. Brit. Mus., II, 1860, p. 372; HOLBROOK, Ichth. S. C., 1860, p. 68, pl. IX, fig. 1; GOODE, Game Fishes U. S., 1879, part second, p. 9, with colored plate.

Scomberomorus maculatus JORDAN & GILBERT, Bull. 16, U. S. Nat. Mus., 1883, p. 426.

East coast of the United States from Cape Cod south to Florida; Gulf of Mexico.

6. Micropterus dolomiei Lacépède. SMALL-MOUTH BLACK BASS.

Micropterus dolomieu LACÉPÈDE, Hist. Nat. Poiss., IV, 1802, pp. 324–326; JORDAN & GILBERT, Syn. Fish. N. A., 1883, p. 485.

Bodianus achigan RAFINESQUE, Amer. Month. Mag., &c., II, 1817, p. 120.

Micropterus achigan GOODE, Game Fishes, U. S., 1879, part second, p. 11, with figure in text.

Calliurus punctulatus RAFINESQUE, Ichth. Ohien., 1820, p. 26.

Cichla fasciata LE SUEUR, Journ. Acad. Nat. Sci. Phila., II, p. 216.

Grystes salmoides CUVIER & VALENCIENNES, Hist. Nat. Poiss., III, 1829, p. 54.

Micropterus salmoides GILL, Proc. Amer. Assoc. Adv. Sci., 1873, p. 67; JORDAN, Man. Vert. N. U. S., ed. 1, 1876, p. 230, and ed. 2, 1878, p. 236.

Grystes salmonoides GÜNTHER, Cat. Fish. Brit. Mus., I, 1859, p. 252.

? Centrarchus fasciatus DE KAY, Nat. Hist. N. Y., Fish., 1842, p. 28, pl. 3, fig. 8 (bad); GÜNTHER, Cat. Fish. Brit. Mus., I, 1859, p. 258.

Centrarchus obscurus DE KAY, Nat. Hist. N. Y., Fish., 1842, p. 30, pl. 17, fig. 48 (47 on the plate).

Great Lake region; Mississippi Valley south to Arkansas; introduced into the Eastern United States, and now becoming abundant from New England to South Carolina. Introduced into England from the United States.

7. Roccus striatus Mitch. STRIPED BASS.

Roccus striatus MITCHILL, Rep. Fish. N. Y., 1814, p. 25.

Labrax lineatus C. & V., Hist. Nat. Poiss., II, 1828, p. 79; DEKAY, Nat. Hist. N. Y., 1842, Fish., p. 7, pl. I, fig. 3; STORER, Synopsis Fish. N. A., 1846, p. 21; HOLBROOK, Ichth. S. C., 1855, p. 17, pl. IV, fig. 1; GÜNTHER, Cat. Fish Brit. Mus., I, 1859, p. 64; STORER, Hist. Fish. Mass., 1867, p. 6, pl. I, fig. 4.

Roccus lineatus GILL, Proc. Acad. Nat. Sci. Phila., 1860, p. 64; GOODE, Game Fishes U. S., 1879, part third, p. 13, with colored plate of young.

Perca mitchilli MITCHILL, Trans. Lit. and Phil. Soc. N. Y., I, 1815, p. 413.

Atlantic coast from the Saint Lawrence to Florida; Gulf of Mexico; (?) Lower Mississippi Valley (Bean); everywhere entering rivers.

8. Roccus americanus (Gmel.) Jor. & Gilb. WHITE PERCH.

Perca americana GMELIN, Syst. Nat., I, iii, 1789, p. 1308.

Labrax americanus HOLBROOK, Ichth. S. C., 1860, p. 20, pl. III, fig. 2.

Morone americana GILL, Proc. Acad. Nat. Sci. Phila., 1860, p. 116.

Roccus americanus JORDAN & GILBERT, Syn. Fish. N. A., 1883, p. 530.

Morone rufa MITCHILL, Rep. Fish. N. Y., 1814, p. 18.

8. **Roccus americanus**, continued.

Labrax rufus DE KAY, Nat. Hist. N. Y., Fish., 1842, p. 9, pl. 3, fig. 7; GÜNTHER, Cat. Fish. Brit. Mus., I, 1859, p. 65; STORER, Hist. Fish. Mass., 1867, p. 9, pl. I, fig. 1.

Morone pallida MITCHILL, Rep. Fish. N. Y., 1814, p. 18.

Labrax pallidus DE KAY, Nat. Hist. N. Y., Fish., 1842, p. 11, pl. 1, fig. 2; GÜNTHER, Cat. Fish. Brit. Mus., I, 1859, p. 67.

Perca mucronata RAFINESQUE, Amer. Month. Mag., &c., II, 1818, p. 205.

Labrax mucronatus CUVIER & VALENCIENNES, Hist. Nat. Poiss., II, 1828, p. 86.

Eastern coast of United States from Cape Cod to Florida, ascending streams. Frequently land-locked in fresh-water ponds.

9. **Chætodipterus faber** (Brouss.) Jor. & Gilb. MOON-FISH; PORGY (Chesapeake).

Chætodon faber BROUSSONET, Ichth. Decas., 1, v, t. 4, 1782 (*fide* Jor. & Gilb.).

Ephippus faber C. & V., Hist. Nat. Poiss., VII, 1831, p. 213; DE KAY, Nat. Hist. N. Y., Fish., 1842, p. 97, pl. XXIII, fig. 68; HOLBROOK, Ichth. S. C., 1855, p. 108, pl. XV, fig. 1 and 1860, p. 110, pl. XV, fig. 1; GÜNTHER, Cat. Fish. Brit. Mus., II, 1860, p. 61.

Chætodipterus faber JORDAN & GILBERT, Bull. No. 16, U. S. National Museum (Syn. Fish. N. A.), 1883, p. 613.

Atlantic coast of the United States from New York to Florida; Gulf of Mexico; West Indies; warm portions of the Pacific north to San Diego (Jor. & Gilb.).

10. **Coregonus clupeiformis** (Mitch.) Milner. COMMON WHITEFISH.

Salmo clupeiformis MITCHILL, Amer. Month. Mag., II, 1818, p. 321.

Coregonus clupeiformis MILNER, in JORDAN, Man. Vert. N. U. S., ed. 2, 1878, p. 362; JORDAN & GILBERT, Syn. Fish. N. A., 1883, p. 299; BEAN, Bull. No. 27, U. S. Nat. Mus., 1883, Sec. F., p. 36.

Coregonus albus LE SUEUR, Journ. Acad. Nat. Sci. Phila., I, 1818, p. 231; DE KAY, Nat. Hist. N. Y., Fish., p. 247 (not represented on pl. LX, fig. 198; GÜNTHER, Cat Fish., Brit. Mus., VI, 1866, p. 184.

Great Lakes: British America, west at least to Manitoba; the young have been distributed as widely as New Zealand.

11. **Coregonus lavaretus** Linné. MARÆNE.

Coregonus lavaretus LINNÉ, Syst. Nat., I, 1766, p. 512; KRÖYER, Danm. Fisk., III, p. 55.

Salmo marœna BLOCH, Syst. Ichth., I, p. 172; III, pp. 148, 164, taf. 27.

Coregonus marœna NILSSON, Prodr., p. 15; C. & V., Hist. Nat. Poiss., XXI, 1848, p. 481, pl. 629.

Coregonus fera, C. & V., Hist. Nat. Poiss., XXI, p. 472.

Great Lakes of Switzerland, Tyrol, Pomerania, Mecklenberg, and Sweden (Günther). Introduced into Lake Gardner, Michigan, by the U. S. Commissioner in 1877.

12. **Salvelinus fontinalis**, (Mich.), Gill. & Jor. BROOK TROUT.

Salmo fontinalis MITCHILL, Trans. Lit. & Phil. Soc. N. Y., I, 1815, p. 435; RICHARDSON, F. B.-A., 1836, p. 176, pl. 83, fig. 1; DE KAY, Nat. Hist. N. Y., Fish., 1842, p. 235, pl. XXXVIII, fig. 120; GÜNTHER, Cat. Fish. Brit. Mus., VI, 1866, p. 152.

Baione fontinalis DE KAY, Nat. Hist. N. Y., Fish., 1842, p. 244, pl. XX, fig. 58.

Salmo erythrogaster DE KAY, Nat. Hist. N. Y., Fish., 1842, p. 236, pl. XXXIX. fig. 126.

Salvelinus fontinalis, GILL & JORDAN, Proc. U. S. Nat. Mus., I, 1878, p. 82; GOODE, Game Fishes U. S., 1879, part first, p. 7, with colored plate; JORDAN & GILBERT, Syn. Fish. N. A., 1883, p. 320; BEAN, Bull. No. 27, U. S. Nat. Mus., 1883, p. 41.

Rivers and lakes of British America and of the northern parts of the United States and Appalachian Range (Goode). Introduced westward and southward.

13. Salvelinus namaycush (Walb.) Goode. LAKE TROUT.

Salmo namaycush WALBAUM, Artedi Gen. Pisc., 1792, p. 68; RICHARDSON, F. B.-A., 1836, p. 179, pl. 79, and pl. 85, fig. 1 (head); KIRTLAND, Bost. Journ. Nat. Hist., iv, 1842, p. 25, pl. iii, fig. 2 (bad); GÜNTHER, Cat. Fish. Brit. Mus., vi, 1866, p. 123.

Salmo amethystus MITCHILL, Journ. Acad. Nat. Sci., Phila., I, 1818, p. 410; DE KAY, Nat. Hist. N. Y., Fish. 1842, p. 240, pl. 76, fig. 241; STORER, Syn. Fish. N. A., 1846, p. 193.

Salar Namaycush VALENCIENNES in C. & V., Hist. Nat. Poiss, XXI, 1848, p. 348.

Cristivomer namaycush GOODE, Game Fishes U. S., 1879, part eight, p. 33, with colored plate.

Salvelinus namaycush JORDAN & GILBERT, Syn. Fish. N. A., 1883, p. 317.

Great Lakes, lakes of Northern New York, New Hampshire, Maine, and north eastward.

14. Salvelinus salvelinus (L.). SÄLBLING; BAVARIAN CHAR.

Salmo salvelinus LINNÉ, Syst. Nat., I, 1766, p. 511; CUVIER & VALENCIENNES, Hist. Nat. Poiss., XXI, 1848, p. 246; GÜNTHER, Cat. Fish. Brit. Mus., VI, 1866, p. 126.

Salmo umbla AGASSIZ, Poiss. d'eau douce, pl. 9.

Alpine lakes of Bavaria and Austria (Günther). Introduced into Plymouth, Massachusetts, by the U. S. Fish Commission.

15. Salmo irideus Gibbons. RAINBOW TROUT.

Salmo iridea GIBBONS, Proc. Cal. Acad. Nat. Sci., I, 1855, pp. 36, 37.

Salmo irideus GÜNTHER, Cat. Fish, Brit. Mus., VI, 1866, p. 119; SUCKLEY, Rep. U. S. Com'r Fish and Fisheries, Part II, 1874, p. 129; JORDAN & GILBERT, Syn. Fish. N. A., 1883, p. 312.

Salar iridea GIRARD, Proc. Acad. Nat. Sci., Phila., 1856, p. 220; and U. S. Pacif. R. R. Exped., Fish, 1858, p. 321, pl. 73, fig. 5, and pl. 74.

Streams west of the Sierra Nevada, from near the Mexican line (Rio San Luis Rey) to Oregon (Jor. & Gilb.). Reared artificially in large numbers by the U. S. Fish Commission on the McCloud River in California, and thence distributed eastward and across the Pacific.

16. Salmo salar Linné. ATLANTIC SALMON.

Salmo salar LINNÉ, Syst. Nat., i, 1766, p. 509; MITCHILL, Trans. Lit. and Phil. Soc. N. Y., 1815, p. 434; RICHARDSON, F. B.-A., 1836, p. 145; STORER, Rep. Fish., &c., Mass., 1839, p. 104; DE KAY, Nat. Hist. N. Y., Fish, 1842, p. 241, pl. 38, fig. 122; GÜNTHER, Cat. Fish. Brit. Mus., VI, 1866, p. 11; STORER, Hist. Fish. Mass., 1867, p. 142, pl. xxv, fig. 2; SUCKLEY, Rep. U. S. Com'r Fish and Fisheries, Part II, 1874, p. 104; GOODE, Game Fishes U. S. 1879, part first, p. 5, with colored plate; JORDAN & GILBERT, Syn. Fish. N. A., 1883, p. 312.

North Atlantic, ascending rivers in Northern Europe and America. In the eastern United States the range of the species has been extended, by the efforts of the U. S. Fish Commission, southward to the Susquehanna River.

17. Salmo salar subsp. **sebago** Girard. LAND-LOCKED-SALMON.

Salmo sebago GIRARD, Proc. Acad. Nat. Sci., Phila., 1853, p. 380; SUCKLEY, Rep. U. S. Com'r Fish and Fisheries, Part II, 1874, p. 143; GÜNTHER, Cat. Fish. Brit. Mus., VI, 1866, p. 153.

Salmo gloveri GIRARD, Proc. Acad Nat. Sci., Phila., 1854, p. 85; GÜNTHER, Cat. Fish. Brit. Mus., VI, 1866, p. 153.

Saint Croix River and lakes of Maine. Extensively introduced into other lakes and into streams southward. The young have been found in abundance in North Carolina, where the Commission introduced the species.

18. **Salmo fario** Linné. RIVER TROUT.

Salmo fario TURTON, Brit. Faun., p. 103; DONOVAN, Brit. Fish., iv, pl. 85; FLEMING, Brit. Anim., p. 181; RICHARDSON, F. B.-A., III, 1836, p. 144, pl. 92, fig. 3 A and B (head); JENYNS, Man. Vert., p. 424; YARRELL, Brit. Fish., 2d edit., ii., p. 85, and 3d edit., i, p. 261; DAY, Fish. Great Brit. and Ireland, Part V, 1882, p. 95, pls. CIX, fig. 3, CXIII, CXIV, and CXVI, fig. 1.

Salmo fario ausonii GÜNTHER, Cat. Fish. Brit. Mus., VI, 1866, p. 64.

A non-migratory species, inhabiting numerous fresh waters of Central Europe, Sweden, and England; rivers of the maritime Alps (Günther). Recently introduced into America.

19. **Oncorhynchus chouicha** (Walb.) Jor. & Gilb. QUINNAT SALMON.

Salmo tshawytscha WALBAUM, Art. Gen. Pisc., 1792, p. 71.

Oncorhynchus choweecha GOODE, Game Fishes U. S., part ten, p. 41, with colored plate.

Oncorhynchus chouicha JORDAN & GILBERT, Syn. Fish. N. A., 1883, p. 306; BEAN, Bull. No. 27, U. S. Nat. Mus., Sec. F, 1883, pp. 32, 38.

Salmo orientalis PALLAS, Zoög. Ross. Asiat., III, 1831, p. 367; CUVIER & VALENCIENNES, Hist. Nat. Poiss., XXI, 1848, p. 356.

Oncorhynchus orientalis GÜNTHER, Cat. Fish. Brit. Mus., VI, 1866, p. 159 (fig. of head).

Salmo quinnat RICHARDSON, F. B.-A., III, 1836, p. 219; STORER, Syn. Fish. N. A., 1846, p. 196; SUCKLEY, Nat. Hist. Wash. Terr., p. 321; Rep. U. S. Com'r Fish and Fisheries, Part II, 1874, p. 105; GIRARD, U. S. Pacif. R. R Exped., Fish., 1858, p. 306, pl. LXVII.

Oncorhynchus quinnat GÜNTHER, Cat. Fish. Brit. Mus., VI, 1866, p. 158.

West coast of the United States from Monterey Bay northward, ascending the Sacramento, Columbia, and other rivers in great numbers; northward to Bering Strait. Extensively reared artificially by the U. S. Fish Commission on the Pacific coast, and widely distributed across seas.

20. **Clupea sapidissima** Wilson. SHAD.

Clupea sapidissima WILSON, Rees's Encycloped. (Amer. edit.); catalogued, but not described [See STORER, Syn. Fish. N. A., 1846, p. 206]; RAFINESQUE, Amer. Month. Mag., Vol. II, Jan. 1818., p. 205; JORDAN & GILBERT, Syn. Fish. N. A., 1883, p. 267.

Clupea alosa MITCHILL, Trans. Lit. and Phil. Soc. N. Y., I, 1815, p. 449.

Alosa vulgaris STORER, Rep. Fish., &c., Mass., 1839, p. 116.

Alosa præstabilis DE KAY, Nat. Hist. N. Y., Fish., 1842, p. 255, pl. 15, fig. 41; STORER, Hist. Fish., Mass., 1867, p. 154, pl. XXVI, fig. 2.

Alosa sapidissima LINSLEY, Cat. Fish. Conn., Silliman's Journ., XLVII; STORER Syn. Fish. N. A., 1846, p. 206; GILL, Cat. Fish. N. A., 1873, p. 33; JORDAN, Man. Vert. E. U. S., ed. i, 1876, p. 265, and ed. ii, 1878, p. 278.

Atlantic coast of North America from Newfoundland to Florida, ascending rivers to spawn; Gulf of Mexico, ascending rivers of the Mississippi Valley (since its introduction by the U. S. Fish Commission); Pacific coast of the United States from California to Oregon; introduced by the U. S. Fish Commission from the East.

21. **Clupea vernalis** MITCHILL. BRANCH HERRING.

Clupea vernalis MITCHILL, Trans. Lit. and Phil. Soc. N. Y., I, 1815, p. 454; JORDAN & GILBERT, Syn. Fish. N. A., 1883, p. 267.

Pomolobus vernalis GOODE & BEAN, Bull, Essex Inst., 1879, p. 24.

Clupea pseudoharengus WILSON, Rees's Encyclop.

Pomolobus pseudoharengus GILL (part), Rep. U. S. Com'r Fish and Fisheries, Part I, 1873, p. 811.

Alosa vernalis STORER, Rep. Fish, &c., Mass., 1839, p. 114.

Atlantic coast of North America from Newfoundland to Florida, ascending

21. Clupea vernalis MITCHILL, continued.

far up the streams; land-locked in Cayuga, Seneca, and other lakes of Western New York; Lake Ontario (probably introduced with shad), and now appearing in myriads in the Upper Saint Lawrence River.

22. Clupea æstivalis Mitchill. GLUT HERRING.

Clupea æstivalis MITCHILL, Trans. Lit. and Phil. Soc. N. Y., I, 1815, p. 456; JORDAN & GILBERT, Syn. Fish. N. A., 1883, p. 267.

Pomolobus æstivalis GOODE & BEAN, Bull. Essex Inst., 1879, p. 24.

Pomolobus pseudoharengus GILL (part), Cat. Fish. E. Coast N. A., 1873, p. 33.

Alosa tyrannus STORER, Hist. Fish. Mass., 1867, p. 156, pl. xxvi, fig. 3 (not of De Kay).

Atlantic coast of the United States, entering streams, but apparently not ascending much beyond tidal waters; it arrives later than the preceding.

23. Clupea harengus Linné. SEA HERRING.

Clupea harengus LINNÉ, Syst. Nat., I, 1766, p. 522; GÜNTHER, Cat. Fish. Brit. Mus., vii, 1868, p. 415; GILL, Cat. Fish. E. Coast N. A., 1873, p. 33; JORDAN & GILBERT, Syn. Fish. N. A., 1883, p. 265.

Clupea elongata LE SUEUR, Jour. Acad. Nat. Sci., Phila., I, p. 234; STORER, Rep. Fish., &c., Mass., 1839, p. 111; DE KAY, Nat. Hist. N. Y., Fish., 1842, p. 250; STORER, Hist. Fish., Mass., 1867, p. 152, pl. XXVI, fig. 1.

Atlantic, abundant on the European and American coasts. Spawns in the fall, and has been artificially reared at Gloucester and elsewhere by the U. Fish Commission.

24. Cyprinus carpio Linné. CARP.

Cyprinus carpio LINNÉ, Syst. Nat., I, 1766, p. 525; GÜNTHER, Cat. Fish. Brit. Mus., VII, 1868, p. 25; JORDAN & GILBERT, Syn. Fish. N. A., 1883, p. 254.

" *Varieties of the integuments:*"

" *Cyprinus nudus* BLOCH, Fische Deutschl., iii, p. 178 (Leder-Karpfen)."

" *Cyprinus specularis* LACÉP.," Hist. Nat. Poiss., v, p. 528."

Temperate parts of Asia, in fresh water; introduced into Europe and North America; widely distributed in the United States by the U. S. Fish Commission.

25. Carassius auratus (L.) Bleeker. GOLD-FISH.

Cyprinus auratus LINNÉ, Syst. Nat., I, 1766, p. 527.

Carassius auratus BLEEKER, "Cypr., p. 255, and Atl. Ichthyol. Cypr., p. 74;" GÜNTHER, Cat. Fish. Brit. Mus., VII, 1868, p. 32; JORDAN & GILBERT, Syn. Fish. N. A., 1883, p. 253.

Japan; China; introduced into Europe and the United States; now well established in many of our eastern streams.

26. Leuciscus idus (L.) subsp. **orfus** L. GOLDEN IDE.

Cyprinus orfus LINNÉ, Syst. Nat., I, 1766, p. 530.

Leuciscus orphus CUVIER & VALENCIENNES, Hist. Nat. Poiss., xvii, 1844, p. 224.

"*Idus melanotus* var. HECKEL & KNER, Süsswasserf., p. 150."

Central and northern parts of Continental Europe (Günther); introduced into the United States by the U. S. Fish Commission, but not yet distributed.

27. Tinca vulgaris (L.) Cuvier. TENCH.

Cyprinus tinca LINNÉ, Syst. Nat., I, 1766, p. 526 (trinca).

Tinca vulgaris CUVIER, Règne Anim., II, 1817, 193; CUVIER & VALENCIENNES, Hist. Nat. Poiss., xvi, 1842, p, 322, pl. 484; GÜNTHER, Cat. Fish. Brit. Mus., VII, 1868, p. 264.

Europe; introduced into the United States by the U. S. Fish Commission. Occasionally found in the Potomac River, into which it has escaped from the ponds in Washington.

UNITED STATES NATIONAL MUSEUM,
Washington, June 7, 1884.

XLIII.—PHYSICAL CHARACTERS OF THE PORTION OF THE CONTINENTAL BORDER, BENEATH THE GULF STREAM, EXPLORED BY THE FISH HAWK, 1880 TO 1882.

By A. E. Verrill.

Although several extended surveys along the region of the Gulf Stream had been made by the officers of the United States Coast Survey since 1844, no systematic dredging had been done along its course, north of Florida, until 1880. During the previous surveys large numbers of bottom samples had been saved. Some of these were studied many years ago by Professor Bailey, and later by Mr. L. F. de Pourtales. Many of the *Foraminifera* and other microscopic forms have been described by them. A few small shells from the same source were described by Dr. A. A. Gould, in 1862. These investigations gave a partial knowledge of the nature of the materials of the bottom and the depth. But many errors existed in the earlier surveys in the determinations of temperature, and little else was known of the physical conditions. In many cases the recorded depths were also unreliable. The extensive surveys made by the Blake since 1880 have been conducted with much better apparatus and far greater accuracy. In 1872 one haul was made by Messrs. S. I. Smith and O. Harger, while on the Bache, in 430 fathoms, south of George's Bank, on this slope, but it happened to be on a comparatively barren spot. In 1877, the United States Fish Commission party dredged on the northward continuation of the Slope, about 120 miles south of Halifax, in 90 and 190 fathoms, but the bottom was of barren gravel and the results meager and unsatisfactory. In that region the cold currents are rapid and the slope of the bottom is exceedingly steep, making the dredgings very difficult.

The real character of the rich fauna inhabiting the bottom beneath the Gulf Stream, off our eastern coast, was completely unknown until 1880,* when numerous and successful dredgings were made, first by Mr.

* The Challenger, on her celebrated voyage, made a line of dredgings from Bermuda toward New York, but after approaching our coast she turned northward, and went to Halifax. Her station nearest to our coast was about 160 miles off New York, in 1,240 fathoms. The few dredgings made by the Challenger off Halifax were partly on the shallow fishing banks (Le Have Bank) and partly in the deep water of the Atlantic Basin. By mere chance, therefore, the Challenger missed the discovery of the exceedingly rich and varied deep-water fauna that is now known to occupy the Gulf Stream Slope at moderate depths all along our coast.

Alexander Agassiz, on the Coast Survey steamer Blake, J. R. Bartlett, U. S. N., commander, and later in the season by the United States Fish Commission party, on the Fish Hawk.

The Blake made several lines of dredgings off our eastern coast, crossing the Gulf Stream Slope. The most southern of these were off the Carolina coasts, and the most northern stations were just south of George's Bank. These dredgings extended from shallow water to about 1,400 fathoms. The Blake was furnished with excellent apparatus for sounding and dredging, temperature determinations, &c. The officers of the Blake secured, by this exploration, a large amount of reliable physical data, and Mr. Agassiz obtained very interesting collections, including large numbers of new forms of animal life, many of which have already been described in the "Bulletin of the Museum of Comparative Zoology." Later in the season of 1880 the United States Fish Commission dredging party, under the supervision of the writer. made its first expedition to the Gulf Stream Slope, in the steamer Fish Hawk, Lieut. Z. L. Tanner commander. The region visited was about 75 to 80 miles south of Martha's Vineyard, in 65 to 192 fathoms. On September 4, when this ground was first visited by us, a long day was spent in dredging and trawling, and with marvelous results. The bottom was found to be occupied by an exceedingly rich and abundant fauna, including great numbers of new and strange forms of animals, belonging to nearly all the marine orders.

This first trip having been so successful, two others were made, later in the season, to other parts of the Slope, in depths ranging from 85 to 500 fathoms. Each trip proved equally productive, and added many species to the long lists of new discoveries.

In 1881 seven trips were made by us to the Gulf Stream Slope, from Wood's Holl, and in 1882 five trips. During these fifteen trips, on most of which a single entire day was employed in dredging, we occupied about 113 stations. At nearly all these stations we used a large trawl of improved construction. In a few instances we used a large rake-dredge.

Our dredgings in this region during the three seasons cover a belt about 160 miles long, east and west, and about 10 to 25 miles wide. The most eastern stations are southeast of Cape Cod, the most western are south of Long Island. They are mostly between 90 and 110 miles from the coast-line of Southern New England (see Plate I). The depths are mostly between 65 and 700 fathoms. Probably no other equally large part of the ocean basin, in similar depths, has been more fully examined than this. In addition to the regular work of the party during the season, Captain Tanner made a special trip to the Gulf Stream Slope, off Chesapeake Bay, in 1880, and another off Delaware Bay, in 1881. On both of these occasions valuable collections were made and additional data in regard to the depths and temperature were obtained. He occupied seven stations, in 18 to 300 fathoms, in 1880,

and eight stations, in 104 to 435 fathoms, in 1881. These dredgings show the direct southward continuation of the inshore cold belt and the warm belt outside of it, as well as the cold deep-water belt, with but little change in the fauna of each.

At most of the localities that we have examined the temperature of the water, both at the bottom and surface, was taken, as well as that of the air. In many cases series of temperatures, at various depths, were also taken. Many other physical observations have also been made and recorded. Lists of the animals from each haul have been made with care and arranged in tables, so far as the species have been determined, up to date. Lists of the fauna will soon be published in these reports.

South of New England the bottom slopes very gradually from the shore to near the 100-fathom line, which is situated from 80 to 100 miles from the mainland. This broad, shallow belt forms, therefore, a nearly level submarine plateau, with a gentle slope seaward. Beyond the 100-fathom line the bottom descends rapidly to more than 1,200 fathoms, into the great ocean basin, thus forming a rapidly-sloping bank, usually as steep as the side of a great mountain chain and about as high as Mount Washington, New Hampshire. This we call the "Gulf Stream Slope," because it underlies the inner portion of the Gulf Stream all along our coast, from Cape Hatteras to Nova Scotia (Plate II). In our explorations a change of locality of less than 10 miles, transverse to the Slope, would sometimes make a difference of more than 3,500 feet in depth.

Farther from the coast the depth continues to increase, but much more gradually, until the depth of about 3,000 fathoms is reached. The Albatross, in 1883, dredged in these deeper waters down to 2,949 fathoms, in N. lat. 37° 12′ 20″, W. long. 69° 39′, station 2099.

INFLUENCE OF THE GULF STREAM.

The bottom along the upper part of this slope and the outermost portion of the adjacent plateau, in 65 to 150 fathoms, and sometimes to 200 fathoms or more, is bathed by the waters of the Gulf Stream. Consequently the temperature of the bottom-water along this belt is decidedly higher than it is along the shallower part of the plateau nearer the shore, in 25 to 60 fathoms. The Gulf Stream itself is usually limited in depth to about 150 fathoms, and often even less, in this region; below this the temperature steadily decreases to the bottom of the ocean basin, where it is about 38°, in 1,000 to 1,400 fathoms. We may, therefore, properly call the upper part of the Slope, in about 65 to 150 fathoms, the "warm belt." According to our observations, the bottom temperature of the warmer part of this belt, in 65 to 125 fathoms, is usually between 47° F. and 53° F., in summer and autumn. Between 150 and 200 fathoms, the temperatures, though variable, are usually high enough to show more or less influence from the Gulf Stream. On the warm belt we took numerous kinds of animals that were previously known

only from the Gulf of Mexico or the Straits of Florida. Some belong to genera that have always been considered as tropical or sub-tropical, such as *Dolium*, *Marginella*, *Solarium*, and *Avicula* among the shells. In fact this belt is occupied by a northern continuation of the southern or West Indian Gulf Stream fauna. Our observations, both on the animal life and the temperature, demonstrate that the western edge of the Gulf Stream is much nearer this coast than it is located on most modern charts. According to our experience the influence of the Gulf Stream becomes decidedly marked, by the rise in temperature a few fathoms below the surface, along a belt corresponding nearly with the 65-fathom line, in summer. This is shown both by the abundant occurrence of the various pelagic animals, gulf-weed, &c., characteristic of the Gulf Stream water farther south, and by the temperatures taken by us. The temperature curves, in 5, 10, 20, 30, and 50 fathoms, all illustrate this, as well as the bottom temperatures. The English Admiralty charts, and others, place the inner edge of the Gulf Stream in summer entirely outside of the Slope, or 40 to 50 miles farther from the coast than we found it. In summer, as is well known, the Gulf Stream is noticed nearer the coast than in winter, but this doubtless applies strictly, or chiefly, only to the surface water. But in summer, owing to the heat of the sun, there is often very little difference between the temperature of the *surface water* at the Gulf Stream and on the inshore plateau. Our investigations show that the warm belt, in 65 to 125 fathoms, is inhabited by a peculiar southern fauna that could not exist there if the Gulf Stream did not flow along this area, at the bottom, both in winter and summer. It is evident that what many of these species require is not a very high, but a *nearly uniform temperature*, all the year round. Such an equable temperature could not exist in this region except under the direct and constant influence of the Gulf Stream. On the lower part of the Slope, in 300 to 780 fathoms, we found numerous arctic forms of life, corresponding to the lower temperature, which at 300 to 500 fathoms is usually 41° F. to 40° F., and at 500 to 1,200 fathoms, 40° F. to 38° F. On the inshore plateau, which is occupied by a branch of the cold, arctic current, about 30 miles wide, we found that the temperature of the bottom water usually varied from 46° F. to 42° F., in August, at the depths of 25 to 60 fathoms. In some instances it was higher than this nearer the shore, and especially opposite the mouths of the bays and sounds, where the tidal flow rapidly mingles the warm surface water (70° F. to 75° F.) with the bottom water.

On the cold part of the shore plateau we also found an abundance of arctic species of animals, such as are found at similar and less depth north of Cape Cod and in the Bay of Fundy. During the colder season of the year the temperature of the water over this plateau is decidedly lower, for codfish even are taken here in large numbers in winter. This plateau, especially over its shallower portions, has, therefore, a *variable cold climate*. But the deep water below 300 fathoms has a *uniform*

cold climate. It is evident that the "warm belt" is here a comparatively narrow one along the bottom, wedged in between the cold waters of the inshore plateau and the still colder waters that cover the outer and deeper part of the Gulf Stream Slope. The actual breadth of this warm belt varies, however, according to the steepness of the slope and in consequence of variations in the currents. Just south of Martha's Vineyard, as will be seen by the map, the slope appears to be less rapid than it is either to the eastward or southward, and consequently there is here a broader area occupied by the warm belt, especially between the 65 and 150 fathom lines. Probably this warm belt finally narrows out and disappears from the bottom before reaching the coast of Nova Scotia. We have hitherto obtained no evidence of such a belt off that coast from temperature observations and the character of the fauna. Therefore it is probable that the cold water of the greater depths there mingles directly with that of the inshore plateau. Southward the warm belt continues to the Straits of Florida, and beyond, the depth of the water characterized by identical temperatures gradually increasing as we go south. At Cape Hatteras this belt becomes very narrow, owing to the abruptness of the slope, and approaches nearer to the shore; but off the Carolina coasts it spreads out over a wide area, which is inhabited by a rich fauna, similar to that investigated by us off Martha's Vineyard. Many of the species are already known to be identical.

In the following summary table are shown the usual range of variation and the approximate average temperature at the bottom in the more characteristic zones of depth, beyond 20 fathoms, in summer:

Fathoms.	Usual range.	Approximate average.
	° F.	° F.
20 to 25	45–51	49
25 to 58	42–46	44
65 to 130	47–53	50
65 to 150	46–53	49.5
150 to 200	43–50	47
200 to 300	41–46	43
300 to 450	40–42	40.5
450 to 600	40–41	40
600 to 800	39–40.5	39.5
800 to 1,400	38–39	38.5

From this table and from the diagrams a few of the published temperature observations, which were abnormally high, have been excluded, because they were probably erroneous, owing to a displacement of the index, or some other accident.

A singular feature of the serial temperatures taken at many stations is illustrated by Plates IV and V. In twenty-nine localities out of thirty-six, where sufficiently full series of temperatures were taken, the temperature was lower at 20 to 30 fathoms than at 50 fathoms. Usually the temperature falls pretty regularly from 5 to 30 fathoms. It then rises often three or four degrees, and sometimes eight to ten degrees, at 50 fathoms, falling again at 100 fathoms, but the temperature at 100 fathoms was often higher than at 30 fathoms. In some cases, as shown

in Plate V, the temperature was lower (45° F.) at 30 fathoms than even at the bottom, in 200 to 250 fathoms. There is, therefore, often a stratum of colder water, in 20 to 40 fathoms, overlying the warmer Gulf Stream water, between 50 and 100 fathoms, in this region. This stratum of cold water may be a lateral extension of the cold water of the inshore plateau, situated at similar depths. Perhaps the greater density of the Gulf Stream water, due to evaporation, may so nearly balance the increase in density due to lower temperature as to make this a phenomenon of constant occurrence at these depths.

It happened, not infrequently, that the surface temperature early in the morning, when we usually began dredging, was one or two degrees lower than that at 5 fathoms, but during the middle of the day the surface water was generally slightly warmer than that at 5 fathoms. These changes are illustrated by some of the lines on Plates III and V.

NATURE AND ORIGIN OF THE SEDIMENTS—OCCURRENCE OF FOSSILIFEROUS MAGNESIAN LIMESTONE-NODULES.

Lists of most of the stations occupied in 1881 and 1882 by the United States Fish Commission steamer Fish Hawk have been given in a pervious article. In the lists the general character of the bo tom is indicated, as well as the depth and temperature.

A detailed description of the materials covering the bottom in this region cannot be given at this time, but certain facts observed by us are of sufficient geological interest to justify a brief notice. At several localities, but especially at stations 1121, 1122, and 1124, in 234, 351, and 640 fathoms, respectively, we dredged fragments and nodular masses, or concretions, of a peculiar calcareous rock, evidently of deep-sea origin, and doubtless formed at or near the places where it was obtained. These specimens varied in size from a few inches in diameter up to one irregular nodular or concretionary mass, taken at station 1124, in 640 fathoms, which was 29 inches long, 14 broad, and 6 thick, with all parts well rounded. This probably weighed 60 pounds or more. The masses differ much in appearance, color, texture, and fineness of grain, but they are all composed of grains of siliceous sand, often very fine, cemented by more or less abundant calcareous matter. In some the grains of sand are large enough to be easily seen by the naked eye, and small quartz pebbles often occur in them, but in others the sand grains are so fine that a microscopic examination is needed to distinguish them. These fine-grained varieties of the rock are often exceedingly compact, heavy, hard, and tough, usually grayish or greenish in color. They usually weather brown, from the presence of iron (probably both as sulphide and carbonate). The sand consists mainly of rounded grains of quartz, with some feldspar, mica, garnet, and magnetite. It is like the loose sand dredged from the bottom in the same region. The calcareous cementing material seems to have been derived mainly from

the shells of foraminifera abundantly disseminated through the sand, just as we find the recent foraminifera, in the same region. In some cases I was able to identify distinct casts of foraminifera in the rock. In some pieces of the rock distinct fossil shells were found, apparently of recent species (*Astarte*, etc.).

The larger masses appear to have been originally concretions in a softer deposit, which has been more or less worn away, leaving the hard nodules so exposed that the trawl could pick them up. The age of these rocks may, however, be as great as the pleistocene, or even the pliocene, so far as the evidence goes. Moreover, it is probable that they belong to a part of the same formation as the masses of fossiliferous sandy limestone and calcareous sandstone often brought up by the Gloucester fishermen from deep water on all the fishing banks from George's to the Grand Bank. No rocks of this kind are found on the dry land of this coast.

The chemical composition of these limestone nodules is of much interest geologically. Analyses made by Prof. O. D. Allen prove that they contain a considerable amount of magnesia. They are, therefore, to be regarded as magnesian limestones or dolomites of recent submarine origin. They also contain a notable quantity of *calcium phosphate*. The presence of the latter is not surprising, when we consider the immense number of carnivorous fishes, Cephalopods, etc., which inhabit these waters, and feed largely upon the smaller fishes, whose comminuted bones must, in part at least, be discharged in their excrements. In fact, it is probable that the greater part of all the mud and sand that covers these bottoms has passed more than once through the intestinal canals of living animals. The *Echini*, *Holothurians*, and many of the star-fishes and worms continually swallow large quantities of mud and sand for the sake of the minute organisms contained in it, and from which they derive their sustenance.

The following partial analysis of one of the limestone nodules is by Prof. O. D. Allen, of the Sheffield Scientific School:

ANALYSIS OF DEEP-SEA LIMESTONE.

(Specific gravity, 2.73.)

Lime	24.95
Magnesia	14.41
Iron, estimated as protoxide	2.00
Insoluble residue	16.97

Throughout the Gulf Stream Slope examined by us the bottom, in 70 to 300 fathoms, 60 to 120 miles from the shore, is composed mainly of very fine sand, largely quartz, with grains of feldspar, mica, magnetite, etc. With it there is always a considerable percentage of shells of foraminifera and other calcareous organisms, and also spherical, rod-like, and stellate, sand-covered rhizopods, often in large quantities. In the deeper localities there is usually more or less genuine mud or clay, but

this is often almost entirely absent, even in 300 to 500 fathoms. The sand, however, is often so fine as to resemble mud, and is frequently so reported when the preliminary soundings are made and recorded. In many instances, even in our deepest dredgings (over 700 fathoms), and throughout the belt examined, we have taken numerous pebbles and small rounded bowlders, of all sizes, up to several pounds in weight, consisting of granite, syenite, mica-schist, etc. These are sometimes abundant and covered with *Actiniæ*, etc. Probably these have been recently floated out to this region, while frozen into the shore-ice, in winter and spring, from our shores and rivers, and dropped in this region, where the ice melts rapidly under the influence of the warmer Gulf Stream water. Possibly much of the sand, especially the coarser portions, may have been transported by the same agency. Another way, generally overlooked, in which fine beach sand may be transported long distances, is by reason of its floating on the surface of the water after it has been exposed to the air on the beaches and dried. The rising tide always carries off a certain amount of fine dry sand floating in this way. In our fine towing nets we always take more or less fine siliceous sand, which evidently was floating on the surface, even at considerable distances from the shore.

The prevalence of fine sand along the Gulf Stream Slope in this region, and the remarkable absence of actual mud or clay deposits indicate that there is here, at the bottom, sufficient current to prevent, for the most part, the deposition of fine argillaceous sediments over the upper portion of the slope, in 65 to 150 fathoms. Such materials are probably carried along till they eventually sink into the greater depths nearer the base of the slope or beyond, in the ocean basin itself, where the currents are less active. It is probable that such a movement of the water may be partly due to tidal currents, as well as to the actual northward flow of the Gulf Stream, which is here slow, even at the surface.* It is not probable, however, that the bottom currents are strong enough to move even the fine sand after it has once actually reached the bottom; nor is it strong enough to prevent the general deposition of oceanic foraminifera, pteropods, etc. I have above suggested that the loose nodules of limestone may have been derived from softer rocks or unconsolidated materials by the removal or wearing away of the latter. The existence of actual currents sufficiently powerful to directly effect such erosion is not supposable. I believe, however, that such a result may be due directly to the habits of certain fishes and crustacea

*Our observations fully demonstrate that the western edge of the Gulf Stream is nearer the coast than it has hitherto been located on the charts. In summer, as is well known, it is nearer the coast than in winter, but this doubtless applies strictly to the *surface water*. Our researches show that the warm belt in 65 to 125 fathoms is inhabited by a peculiar southern fauna that could not exist there if the Gulf Stream did not flow along this area *at the bottom* both in winter and summer. But it is evident that what many of these species require is not a very *high* but a *nearly uniform* temperature. Such an equable temperature cannot exist in this region except under the direct and constant influence of the Gulf Stream.

that abound on these bottoms. Many fishes, like the "hake" (*Phycis*), of which two species are common here, have the habit of rooting in the mud like pigs for their food, which consists largely of Annelida and other mud-dwelling creatures. Other fishes, those with sharp tails especially, burrow actively into the mud or sand, tail first, and in all probability *Macrurus*, abundant in this region, has this habit. Several species of eels and eel-like fishes are very abundant on these bottoms. These are all burrowers. The "slime-eel" or hag (*Myxine glutinosa*) was also taken in large numbers both in the trawl and in traps. Many crabs and allied forms are active burrowers. Such creatures, by stirring up the bottom sediments continually, would give the currents a chance to carry away the finer and lighter materials, leaving the coarser behind.

In many localities in the region under consideration there are great quantities of dead shells, both broken and entire. A small proportion of the bivalves have been drilled by carnivorous gastropods, but there are large numbers that show no injury whatever. There is no doubt in my mind but that these have for the most part served as food for the star-fishes and large Actiniæ, so abundant on these grounds, and from which I have often taken entire shells of many kinds, including pteropods. Many fishes, like the cod, haddock, hake, etc., have the habit of swallowing shells entire, and after digesting the contents, they disgorge the uninjured shells, and such fishes abound here.

The mollusks represented by the numerous broken shells have probably been preyed upon by the crabs and other crustacea, having claws strong enough to crack the shells. The large species of *Cancer* and *Geryon*, and the larger Paguroids, abundant in this region, have strength sufficient to break most of the bivalve shells. Although I have often seen such crustacea break open bivalves for food, I am well aware that they also feed on other things.* Many fishes that feed on mollusca break the shells before swallowing them, so that both fishes and crabs have doubtless helped to accumulate the broken shells that are very often scattered abundantly over the bottom, both in deep and in shallow water. Such accumulations of shells would soon become far more extensive if they were not attacked by boring sponges and annelids. Certain common sponges belonging to the genus *Cliona* very rapidly perforate the hardest shells in every direction, making irregular galleries, and finally utterly destroy them. In our shallower waters the most destructive species is *C. sulphurea* (Desor), which burrows in shells and limestone

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*I have observed that when in aquaria, many different species of the larger crustacea, such as the crabs, *Libinia emarginata*, *Cancer irroratus*, *Panopeus Sayi*, *Carcinas mœnas*, *Platyonicus occellatus*; the hermit-crabs, *Eupagurus pollicaris*, *E. longicarpus*, and *Catapagurus socialis*; the shrimp, *Palæmonetes vulgaris* and *Virbius zostericola*; and *Limulus polyphemus*, are all extravagantly fond of the masses of diatoms and other fine algæ, intermingled with copeopods, etc., which we often collect in our surface-nets. When a mass of such materials is thrown into an aquarium containing these crustacea they seize and devour it with great avidity.

when young, but later grows into large, rounded, sulphur-yellow masses, often a foot in diameter. In deep water other species occur. Rarely, we dredge up, on the outer grounds, fragments of wood, but these are generally perforated by the borings of bivalves (usually *Xylophaga dorsalis*) and other creatures, and are evidently thus soon destroyed. Very rarely do we meet with the bones of vertebrates at a distance from the coast. Although these waters swarm with vast schools of fishes, while sharks and a large sea-porpoise or dolphin (*Delphinus delphis*) occur in large numbers, we have, very rarely indeed, dredged up any of their bones, or, in fact, remains of any other vertebrate animals. In a few instances we have dredged a single example of a shark's tooth, and occasionally the hard otoliths of fishes. It is certain that not merely the flesh, but most of the bones, also, of all vertebrates that die in this region are very speedily devoured by the various animals that inhabit the bottom. Echini are very fond of fish-bones, which they rapidly consume.

Relics of man and his works are of extremely rare occurrence, at a distance from the coast, or outside of harbors, with the exception of the clinkers and fragments of coal thrown overboard with the ashes from steamers. As our dredgings are in the track of European steamers, such materials are not rare. A few years ago even these would not have occurred. A rock forming on this sea-bottom would, therefore, contain little evidence of the existence of man, or even of the existence of the commonest fishes and cetaceans inhabiting the same waters.

EVIDENCES OF THE EXISTENCE OF LIGHT AT GREAT DEPTHS.

The evidences of the presence of light at great depths and its quality and source are of much interest. At present very little experimental knowledge in regard to these questions is available. That light of some kind and in considerable amount actually exists at depths below 2,000 fathoms may be regarded as certain. This is shown by the presence of well-developed eyes in most of the fishes, all of the Cephalopods, most of the decapod Crustacea, and in some species of other groups. In many of these animals living in 2,000 to 3,000 fathoms, and even deeper than that, the eyes are relatively larger than in the allied shallow-water species; in others the eyes differ little, if any, in size and appearance from the eyes of corresponding shallow-water forms; in certain other cases, especially among the lower groups, the eyes are either rudimentary or wanting in species of which the shallow-water representatives have eyes of some sort. This last condition is notable among the deep-water Gastropods, which are mostly blind, but many of these are probably burrowing species, and it may be that the prevalent extreme softness of the ooze of the bottom and the general burrowing habits are connected directly with the absence or rudimentary condition of the eyes in many species belonging to different classes, including Crustacea and fishes. Such blind species usually have highly-developed tactile organs, to compensate for lack of vision.

Other important facts, bearing directly, not only on the *existence*, but on the *quality*, of the light, are those connected with the coloration of the deep-sea species. In general it may be said that a large proportion of the deep-sea animals are highly *colored*, and that their colors are certainly *protective*. Certain species, belonging to different groups, have pale colors or are translucent, while many agree in color with the mud and ooze of the bottom, but some, especially among the fishes, are very dark or even almost black. Most of these are probably instances of adaptations for protection from enemies or concealment from prey. But more striking instances are to be found among the numerous brightly colored species belonging to the Echinoderms, decapod Crustacea, Cephalopods, Annelids, and Anthozoa. In all these groups species occur which are as highly colored as their shallow-water allies, or even more so. But it is remarkable that in the deep-sea animals the bright colors are almost always shades of orange and orange-red, occasionally purple, purplish-red, and brownish-red. Clear yellow, and all shades of green and blue colors are rarely, if ever, met with. These facts indicate that the deep sea is illuminated only by the sea-green sunlight that has passed through a vast stratum of water, and therefore lost all the red and orange rays by absorption. The transmitted rays of light could not be reflected by the animals referred to, and therefore they would be rendered invisible. Their bright colors can only become visible when they are brought up into the white sunlight. These bright colors are, therefore, just as much protective as the dull and black colors of other species.

The deep-sea star-fishes are nearly all orange, orange-red, or scarlet, even down to 3,000 fathoms; the larger Ophiurans are generally orange, orange-yellow, or yellowish white, the burrowing forms being usually whitish or mud-colored, while the numerous species that live clinging to the branches of gorgonians and the stems of Pennatulacea are generally orange, scarlet, or red, like the corals to which they cling. Among such species are *Astrochele Lymani*, abundant on the bushy orange gorgonian coral, *Acanella Normani*, often in company with several other orange Ophiurans, belonging to *Ophiacantha*, etc. *Astronyx Loveni* and other species are common on Pennatulacea, and agree very perfectly in color with them. These and numerous others that might be named are instances of the special adaptations of colors and habits of commensals for the benefit of one or both. Many of the large and very abundant Actinæ or sea-anemones are bright orange, red, scarlet, or rosy in their colors, and are often elegantly varied and striped, quite as brilliantly as the shallow water forms, and the same is true of the large and elegant cup-corals, *Flabellum Goodei*, *F. angulare*, and *Caryophyllia communis*, all of which are strictly deep-sea species and have bright orange and red animals when living. The gorgonian corals, of many species, and the numerous sea-pens and sea-feathers (Pennatulacea), which are large and abundant in the deep sea, are nearly all bright colored, when

living, and either orange or red. All these Anthozoa are furnished with powerful stinging organs for offense and defense, so that their colors cannot well be for mere protection against enemies, for even the most ravenous fishes seldom disturb them. It is probable, therefore, that their invisible colors may be of use by concealing them from their prey, which must actually come in contact with these nearly stationary animals, in order to be caught. But there is a large species of scale covered annelid (*Polynoë aurantiaca* V.) which lives habitually as a commensal, on *Bolocera Tuediæ*, a very large orange-red actinian, with unusually powerful stinging organs. Doubtless the worm finds on this account perfect protection against fishes and other enemies. This annelid is of the same intense orange color as its actinian host. Such a color is very unusual among annelids of this group, and in this case we must regard it as evidently protective and adaptive in a very complex manner.

It has been urged by several writers that the light in the deep sea is derived from the phosphorescence of the animals themselves. It is true that many of the deep-sea Anthozoa, Hydroids, Ophiurans, and fishes are phosphorescent, and very likely this property is possessed by members of other groups in which it has not been observed. But so far as known, phosphorescence is chiefly developed in consequence of nervous excitement or irritation, and is evidently chiefly of use as a means of defense against enemies. It is possessed by so many Anthozoa and Acalephs which have, at the same time, stinging organs, that it would seem as if fishes had learned to instinctively avoid all phosphorescent animals. Consequently, it has become possible for animals otherwise defenseless to obtain protection by acquiring this property. It is well known to fishermen that fishes avoid nets and cannot be caught in them if phosphorescent jelly-fishes become entangled in the meshes. Therefore it can hardly be possible that there can be an amount of phosphorescent light regularly evolved by the few deep-sea animals having this power sufficient to cause any general illumination, or powerful enough to have influenced, over the whole ocean, the evolution of complex eyes, brilliant and complex protective colors, and complex commensal adaptations.

It seems to me probable that more or less of the sunlight does actually penetrate to the greatest depths of the ocean, in the form of a soft sea-green light, perhaps at 2,000 to 3,000 fathoms equal in intensity to our partially moonlight nights, and possibly, at the greatest depths, equal only to starlight. It must be remembered that in the deep sea, far from land, the water is far more transparent than near the coast.

EXPLANATION OF THE PLATES.

PLATE I.

Sketch map of the southern coast of New England to the Gulf Stream Slope, showing lines of depth and the position of the principal dredging stations of the United States Fish Commission, 1880–1882, and some of those of 1871, 1874, and 1875. The crosses indicate dredging stations, part of which are accompanied by their serial numbers, corresponding to the records and published lists. Those bearing numbers between 309 and 347 were occupied by the Blake in 1880.

PLATE II.

To illustrate the relative slope or profile of the bottom from the shore to the Gulf Stream Slope and across portions of the slope in several lines. Vertical to horizontal scale, 1:360. The line *n'—o'* shows the actual slope along the line *n—o*. The vertical shading indicates the position of the comparatively warm water both of the surface and of the Gulf Stream; oblique shading to the right indicates the cold water of the shallow plateau; oblique to the left the cold water of the greater depths.

PLATE III.

Temperature-curves at the bottom and surface (*o*), and at 5, 10, and 20 fathoms in the same localities. The curves of the bottom-temperatures extend from the shore to near the 800-fathom line on the Gulf Stream Slope. The position of each station is indicated by the total depth placed at the head of the vertical columns.

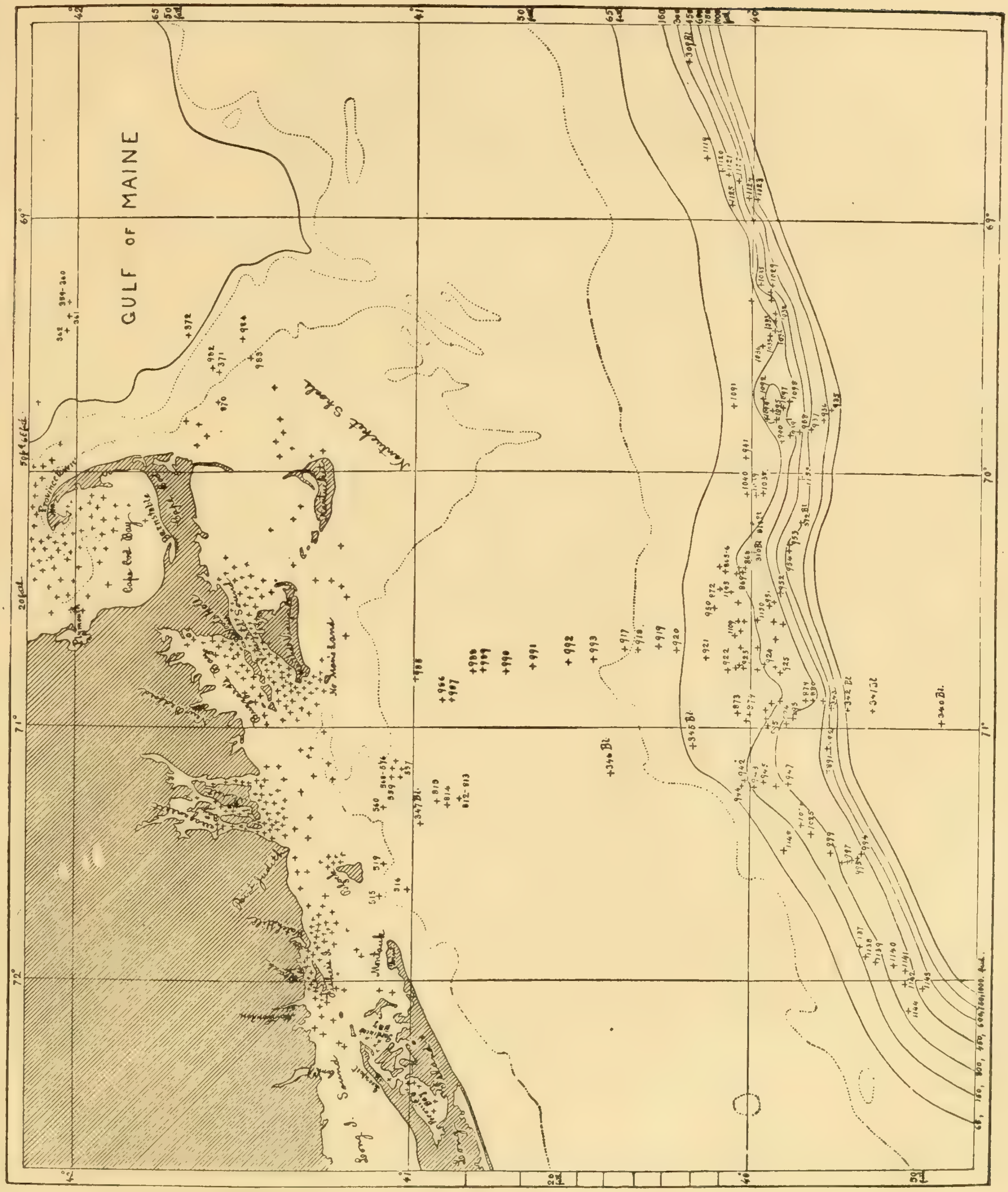
PLATE IV.

Temperature-curves at the surface and bottom, and at the intermediate depths of 5, 10, 20, 30, and 50 fathoms, arranged according to the distance in miles from the shore. The observations were made on three different days, as indicated by the letters *a—a*, *b—b*, *c—c*. The dotted lines indicate breaks in the actual series of observations. The numbers are those of the recorded stations where the observations were made.

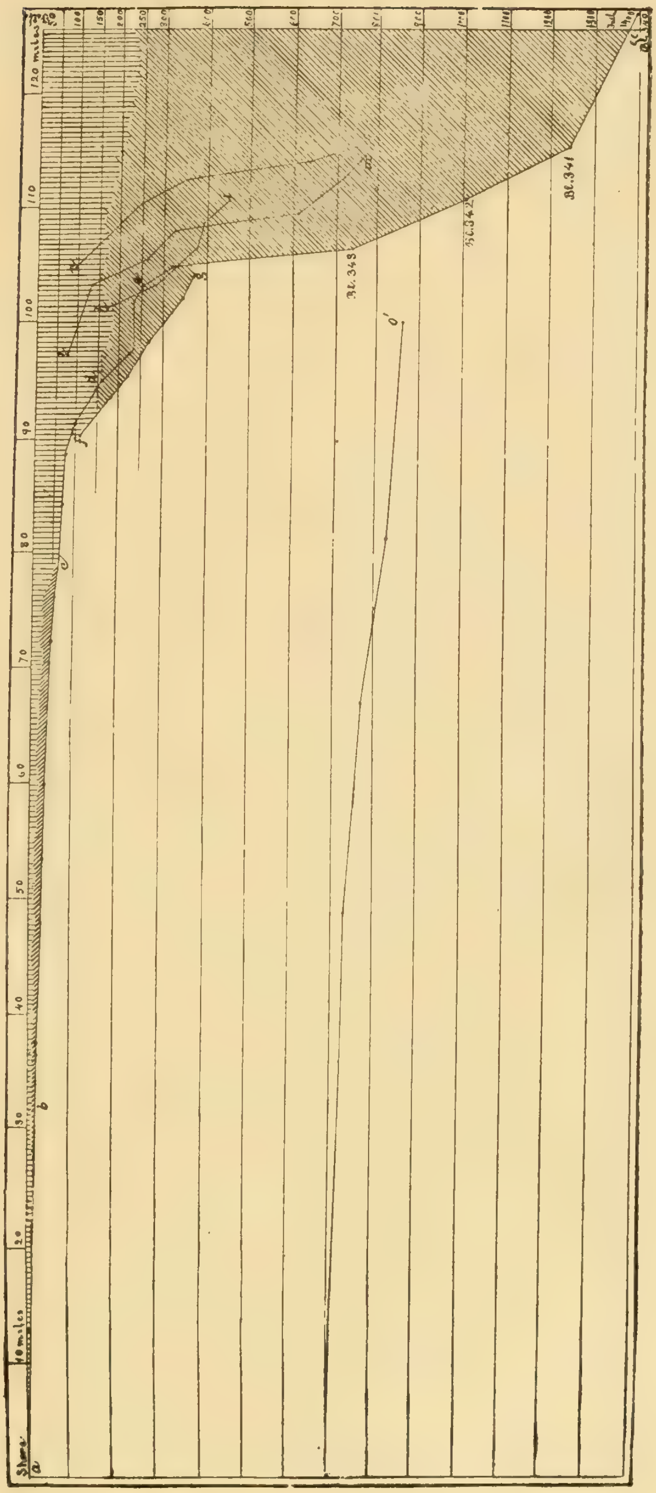
PLATE V.

Temperature-curves at the bottom and surface (*o*), and at the intermediate depths of 5, 10, 20, 30, 50, and 100 fathoms. These observations were all made September 14, 1881. This illustrates the rise in temperature between 30 and 50 fathoms from the surface.

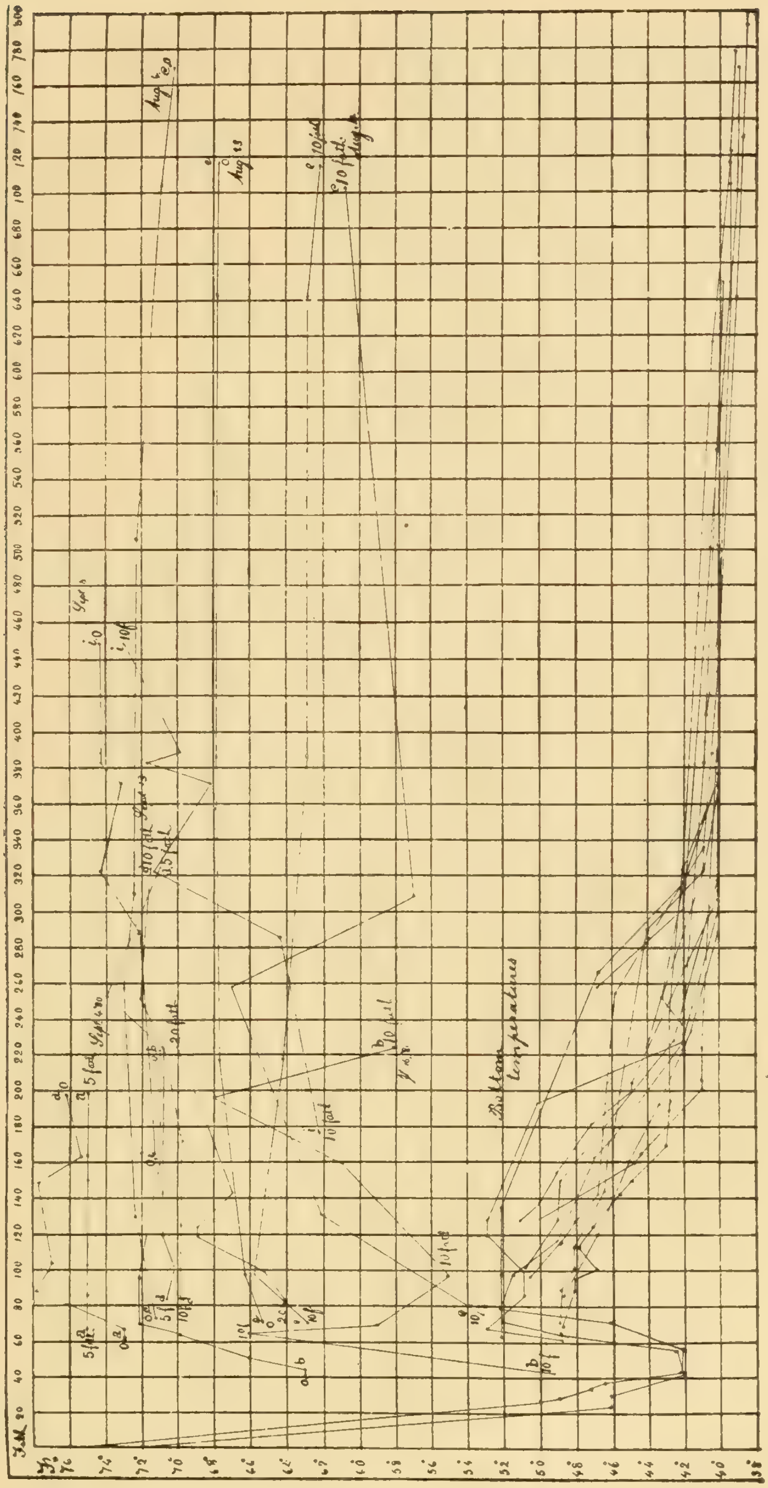
These plates were prepared to illustrate articles published by me in "Science," in 1882. I am indebted to the editor, Mr. S. H. Scudder, for the opportunity of using them in this place.



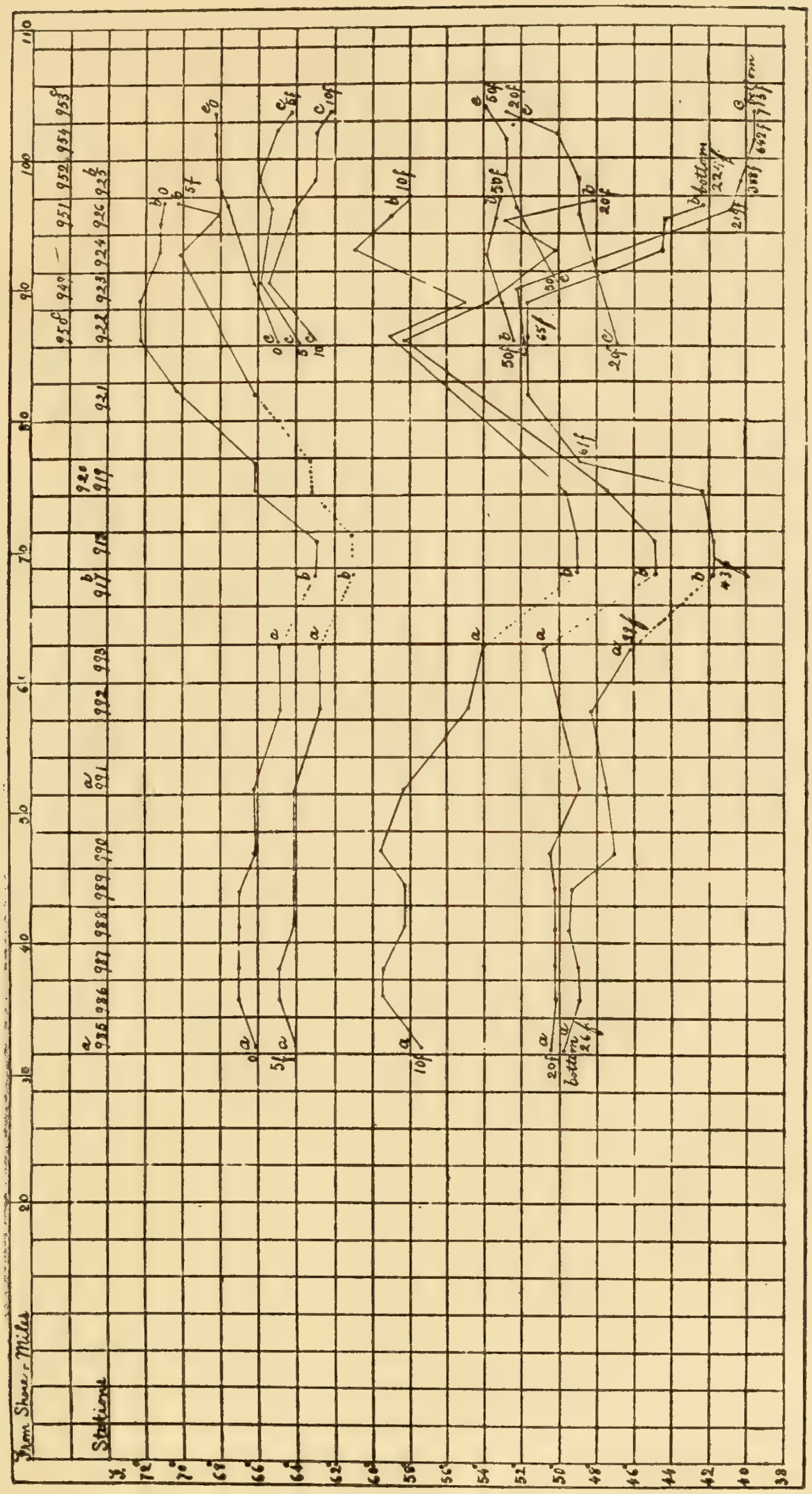
Southern coast of New England to the Gulf Stream Slope, showing lines of depth and positions of the principal dredging-stations of the United States Fish Commission.



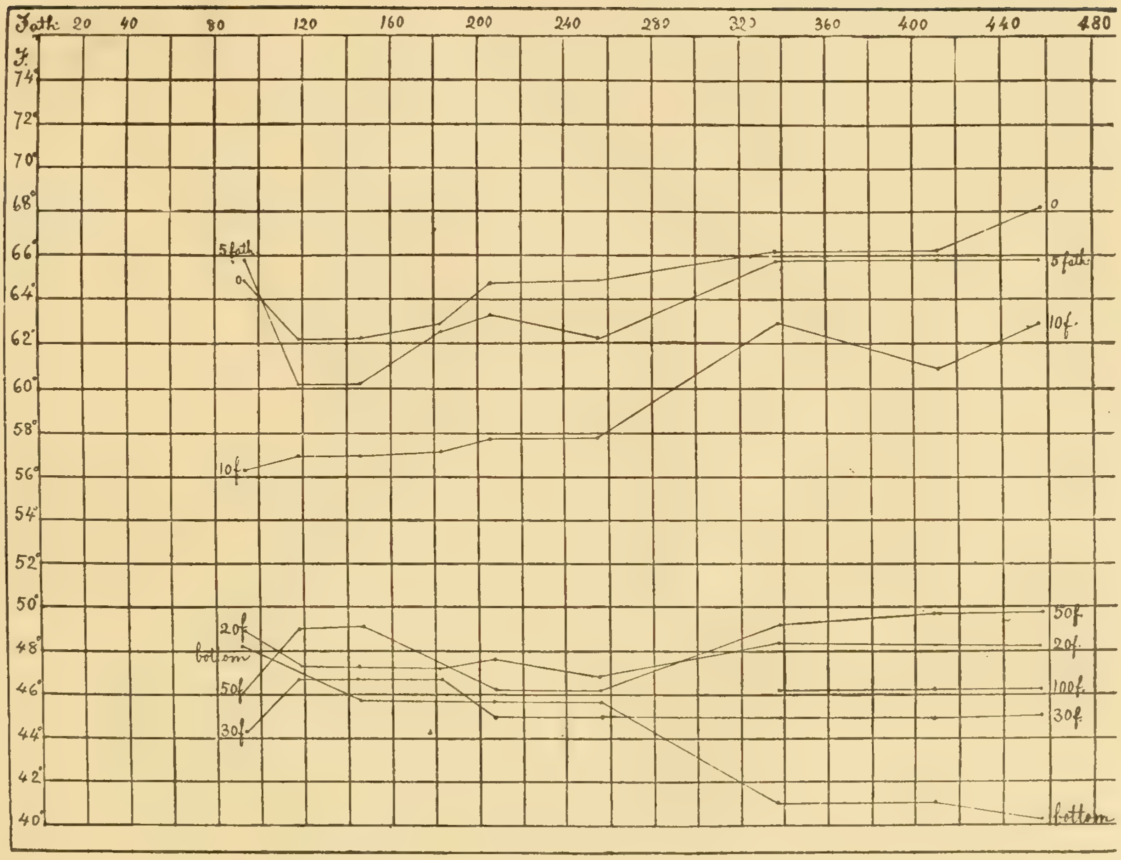
To illustrate the relative slope or profile of the bottom, from the shore to the Gulf Stream Slope, and across portions of the slope in several lines. Vertical to horizontal scale, 1:360.



Temperature curves at the bottom and surface (o), and at 5, 10, and 20 fathoms, and extending from the shore to near the 800-fathom line on the Gulf Stream Slope.



Temperature curves at the surface and bottom, and at the intermediate depths of 5, 10, 20, 30, and 50 fathoms, arranged according to the distance in miles from the shore.



Temperature curves at the bottom and surface (o), and at the intermediate depths of 5, 10, 20, 30, 50, and 100 fathoms.

XLIV.—ALPHABETICAL INDEX TO THE PRINCIPAL RIVERS OF THE UNITED STATES.

By Chas. W. Smiley.

This is in reality an index to the classified list of rivers and their tributaries presented on pages 91–202 of this volume, and the references are to the classification there used. In order to avoid the constant repetition of the words "river," "creek," &c., exponent figures in small type have been placed against each name to denote the character of the body of water, viz:

1 River.	6 Brook.	11 Sound.
2 Creek.	7 Branch.	12 Slough.
3 Lake.	8 Pond.	13 Stream.
4 Bayou.	9 Bay.	
5 Wash.	10 Run.	

The work of preparation of this index has been done very largely by Messrs. S. S. Alden, C. E. Latimer, and E. Y. Davidson.

This index is believed to be a faithful guide to all streams named in the preceding article. It will be of considerable service in the work of the Commission, and it is hoped of others. It is manifestly impossible to note every little creek in the country, and in the omissions may have been included accidentally some of respectable size. If time should permit, the list could be much enlarged and improved. It is now presented as so much better than nothing and to meet a felt want.

INDEX.

NOTE.—This index contains general references to the entire volume. More detailed indexes to eleven papers will be found at the pages indicated.

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T.